Identifying changes in dietary intake, diet quality, body weight and body composition during first year university

by

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ABSTRACT

The purpose of this study was to identify if dietary intake and eating habits change in students during first-year university and how these changes influence anthropometrics and body composition. 301 students (*n*=71 males, *n*=230 females) completed food frequency and dietary habits questionnaires. Anthropometry and body composition were measured at the beginning and end of first-year university. Both males and females gained body weight ($p<0.05$). Both gained fat mass and males gained significantly more lean mass than females. Energy intake significantly decreased by ~400 kcals/d for both sexes. Diet quality also decreased in both sexes characterized by negative changes in healthy and unhealthy foods. Caffeine intake remained the same and alcohol intake increased. Therefore, modest weight gain does occur during first-year university, males more than females, but the composition was different. Dietary intake and quality decreased in both sexes and changes in some dietary habits reflected these negative intake changes.

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CONTRIBUTIONS

All data (demographic, anthropometric, and body composition data and saliva samples) were collected by Kayleigh M. Beaudry and Aysha M. Thomas. Food frequency questionnaire data was collected by Kayleigh M. Beaudry and analyzed by NutritionQuest. Further analysis on the questionnaire output was performed by Kayleigh M. Beaudry. Saliva samples were prepared for cortisol analysis by Kayleigh M. Beaudry and Aysha M. Thomas. Salivary cortisol was analyzed by Dr. Cameron Muir. All statistical analyses, writing and interpretation was done by Kayleigh M. Beaudry with input and guidance from Dr. Andrea R Josse as well as Drs. Bareket Falk and Wendy Ward.

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ABBREVIATIONS

%BF	Percent body fat
AA	Arachidonic acid
ACTH	Adrenocorticotropic hormone
AHS	Applied health sciences
AI	Adequate intake
ALA	Alpha-linolenic acid
AMDR	Acceptable macronutrient distribution ranges
ANOVA	Analysis of variance
BIA	Bioelectrical impedance analysis
BMI	Body mass index
BMR	Basal metabolic rate
BMX	Bodymetrix
CHD	Coronary heart disease
CRH	Corticotrophin releasing hormone
CVD	Cardiovascular disease
DHA	Docosahexaenoic acid
DQI	Diet quality index
DRI	Dietary reference intakes
DXA	Dual energy x-ray absorptiometry
EAR	Estimated average requirement
ECW	Extra cellular water
EPA	Eicosapentaenoic acid
FA	Fatty acid

FFM	Fat free mass
FFQ	Food frequency questionnaire
g	Grams
g/d	Grams per day
HDL	High-density lipoprotein
HEI	Healthy eating index
HFCS	High-fructose corn syrup
HPA Axis	Hypothalamic–pituitary–adrenal axis
ICW	Intra cellular water
IOM	Institute of medicine
Kcal	Kilocalories
kg	Kilograms
LA	Linoleic acid
LBM	Lean body mass
lbs	Pounds
LDL	Low-density lipoprotein
MUFA	Monounsaturated fatty acid
NFM	Non-fat mass
PUFA	Polyunsaturated fatty acid
RDA	Recommended dietary allowance
SAT	Subcutaneous adipose tissue
SFA	Saturated fatty acid
TBW	Total body water
TEF	Thermic effect of food

TFM	Total fat mass
UL	Tolerable upper intake level
VAT	Visceral adipose tissue
WHR	Waist to hip ratio

CHAPTER 1: INTRODUCTION

1.1 Rationale and Purpose

The rates of overweight and obesity are increasing in the world population. According to a 2014 World Health Organization report, 1.9 billion of the world's population is overweight and an additional 600 million are obese [1]. This equates to roughly 39% of adults aged 18 and over being overweight and an additional 13% being obese. When looking at trends worldwide for body weight changes over the lifespan, a critical time period for weight gain appears to be in young adulthood [2-4]. During young adulthood individuals are creating habits that are likely sustained into adulthood. Therefore, during critical time periods, especially during the transition from high school to university, it is important to make students aware of factors that may affect this transition and contribute to body weight change [5]. Entering university is a big change to a student's environment as it is usually a time when they begin their independent adult life. This is also a time when new university students may adopt an unhealthy lifestyle [3]. This transition may add stress and these lifestyle changes could contribute to weight gain during their first-year at university. This unhealthy lifestyle may include: smoking, alcohol consumption, increased stress, a decrease in physical activity, lack of sleep and poor food choices/eating habits. Moreover, these lifestyle changes may have negative long-term implications for health across the lifespan [5].

There is a common perception that during the first-year of university, a students' lifestyle undergoes undesirable changes that may lead to weight gain and body composition change characterized by an increase in body fat and an increase in waist to hip ratio. This weight gain is often referred to as the "Freshman 15". The "Freshman 15" is the popular notion that students generally gain upwards of 6.8kg (15lbs) of weight during their first-year at college or university [4]. While some first-year students gain around 15lbs or more [3], a recent review has shown that the typical weight gain averages between 0.73kg to 4kg (1.6lbs to 8.8lbs), and some studies found no significant weight gain [4]. Furthermore, and of direct relevance to this thesis, little data exist on the exact role that changes in dietary intake and quality may play during this time period. This is important because the lifestyle habits that young adults create during this transition period, especially as it pertains to dietary intake and quality may be continued throughout the lifespan.

Changes in dietary intake have been shown to be one of the major lifestyle changes that occur in students during the transition to university life [3, 6]. Based on a study of 47 male and female first-year students from Malawi, Africa, food frequency questionnaire (FFQ) data showed changes in intakes of certain foods from the beginning to end of first-year [3]. They demonstrated that the percentage of students consuming wheat and meat products more than once per day had nearly doubled, from 13.0 to 24.4% of students consuming wheat products (such as pasta, rice, potatoes, etc.) and 12.8 to 25.5% of students

consuming meat and meat products (such as steak, eggs, etc.) [3]. Similar increases were observed for the intake of sugar, milk and margarine eaten more than once per day in these participants. They also showed a decline in the percentage students eating fish once or twice per week (44.7 to 11.4%), and dark green leafy vegetables (31.8 to 8.9%), and fruit (9.1 to 0%), eaten once or twice per day [3].

However, not all studies examining nutritional changes during first-year university found similar results. One study examining the intake of energy and macronutrients among 128 female students did not observe any significant dietary changes over one year. Dietary intake was measured using 24-hour dietary recalls at three different time points during the year; Summer, Fall and Winter [7]. In another study performed on 108 male students who attended summer, fall and winter study visits, there were no significant differences in intakes of energy, macronutrients or micronutrients while also using 24-hour dietary recalls [8]. However, this study did report a significant decrease in the consumption of fruit, milk and milk products between the summer and fall study visits [8]. Although there are examples of how dietary intake may change during first-year of university in current literature [3], most studies focus on total energy intake, energy intake broken down into macronutrients and the reporting of select micronutrients [7, 8], while very few studies have assessed total energy intake along with the actual foods first-year students are eating [3, 7, 8]. In addition, few of these studies also measured body composition as it relates the nutrition and

dietary intake, and none that measured body composition as it relates to diet quality [7, 8].

Therefore, the purpose of this study was to determine, in first-year students at Brock University, whether there are changes in dietary intake, diet quality and dietary habits over the first-year, and whether these changes influence body weight, body composition and stress levels. We quantified the intake of macronutrients, micronutrients, overall energy intake and different foods from a FFQ administered during the beginning and end of first-year. These data allowed us to ascertain if there are differences in food and nutrient intake as well as diet quality from the beginning to end of first-year. We also assessed intake in several subgroups including different sexes, students with different living arrangements (i.e. on campus versus. off campus) and those in different Faculties. Eating behaviors were also assessed that could help to explain differences in intakes. Overall, this study identified changes in dietary intake, diet quality and eating behaviors, which may influence weight and body composition change during the first-year of university. The information collected from this study is important as it can be used to further inform programs that will help students lead healthier lives not only throughout university but also across the lifespan.

1.2 Objectives and Hypotheses

1.2.1 Objectives

The first primary objective of this study was to identify if dietary intake and diet quality change in students throughout their first-year of university and how this may differ based on sex. The second primary objective was to determine how changes in diet quality influence anthropometrics and body composition based on sex. Secondary objectives include:

(1) To identify whether living arrangements and Faculty play a role in these dietary changes.

(2) To identify whether changes in dietary intake, eating behaviors/habits or body weight/composition relate to a physiological measure of stress.

(3) Identify whether eating behaviors/habits change over the course of the first-year of university. These changes may include binge eating, disordered eating and overeating.

1.2.2 Hypotheses

The first primary hypothesis of this study was that there will be negative changes in dietary intake, diet quality and eating behaviors/habits in students from the beginning to the end of the first-year, these changes will also be different based on sex. This will be characterized by an increased reliance on fast food and decreased fresh fruit and vegetable intake which will ultimately lead to an increase in energy intake and a decrease in vitamin and mineral intake. The

second primary hypothesis is that these changes in dietary intake will negatively affect body composition and anthropometric measures such that there will be an increase in total fat mass and body weight that will differ based on sex.

Secondary hypotheses are the following:

(1) Changes in nutrition and body composition will differ based on living arrangement and Faculty during the first-year of university.

(2) Changes in dietary intake reflective of poorer eating habits will correlate with increased stress reflected in an increase in salivary cortisol levels.

(3) Changes in dietary intake during first-year university will reflect changes in eating behaviors/habits to include behaviours like binge eating, disordered eating and overeating.

CHAPTER 2: REVIEW OF LITERATURE

2.1 Nutrition

2.1.1 Energy and energy balance

Food is the source of essential elements and building blocks to synthesize new tissue, preserve lean body mass, optimize skeletal structure, repair existing cells, maximize oxygen transport and use, maintain favourable fluid and electrolyte balance and regulate all metabolic processes [9]. Energy is defined as the ability to do work [10] and is required to sustain the body's various functions, including respiration, circulation, physical work and maintenance of core body temperature [11]. In nutrition, energy is measured in kilocalories (kcal). kcal is a measure of the amount of energy that is supplied to or expended by the body [10]. The energy that is found in foods is released in the body by oxidation yielding the chemical energy needed to sustain metabolism, respiration, circulation and muscle contraction [12]. Carbohydrate, fat, protein and alcohol provide all the energy supplied by foods and are generally referred to as macronutrients.

Energy balance in an individual depends on their dietary energy intake and energy expenditure. The basic components to energy balance include energy intake and energy expenditure [11]. Energy intake is provided by macronutrients as previously mentioned. The total amount of energy used by the body each day is called total energy expenditure (TEE) [10]. TEE included the energy expended through basal metabolism (including both basal metabolic rate

and resting metabolic rate), the thermal effect of food (diet-induced thermogenesis), adaptive thermogenesis and the energy expended through physical activity [4]. When energy intake equals energy expenditure, the body is in energy balance and body weight remains stable [11]. Body weight can change when energy intake is not equal to energy expenditure over an extended period of time [11]. That is, imbalances between intake and expenditure result in gains or losses of body components such as fat and muscle (and to a lesser extent, bone), and these will ultimately lead to changes in body weight [12]. Chronic positive energy balance (when energy intake outweighs energy expenditure) will ultimately lead to overweight and obesity [13]. In fact, when energy intake consistently exceeds energy expenditure, a state of positive energy balance occurs and there is consequently an increase in body mass, of which 60 to 80% is usually body fat [11]. In most cases, this is largely due to behavioural factors rather than metabolic or disease factors [14]. Conversely, when energy expenditure exceeds energy intake, a state of negative energy balance ensues and causes a loss of body mass which again is usually 60 to 80% body fat [11].

2.1.2 Dietary Reference Intakes

The dietary reference intakes (DRIs) are a system of nutrient recommendations from the institute of medicine (IOM) of the National Academy of Sciences. The DRIs provide several different types of reference values for macronutrients and micronutrients. The DRIs have different sub-classifications.

They are: estimated average requirement (EAR), recommended dietary allowance (RDA), adequate intake (AI) and tolerable upper intake level (UL). For macronutrients, there are the estimated energy requirement (EER) and the acceptable macronutrient distribution ranges (AMDR). More detailed information on each of the DRIs is provided in Table 1.

Table 1: Dietary reference intakes (DRI) [12]

Dietary Reference Intakes	Description
Recommended Dietary Allowance (RDA)	The average daily dietary nutrient intake level sufficient to meet the nutrient requirement of nearly all (97-98%) healthy individuals in a particular life stage and gender group
Adequate Intake (AI)	The recommended average daily intake level based on observed or experimental determined approximations or estimates of nutrient intake by a group (or groups) of apparently healthy people that are assumed to be adequate- used when an RDA cannot be determined
Upper Intake Level (UL)	The highest average daily nutrient intake level that is likely to pose no risk of adverse health effects to almost all individuals in the general population. As intake increases above the UL, the potential risk of adverse effects may increase.
Estimated Average Requirement (EAR)	The average daily nutrient intake level estimated to meet the requirement of half the healthy individuals in a particular life stage and gender group.
Estimated Energy Requirement (EER)	The average dietary energy intake that is predicted to maintain energy balance in a healthy adult of a defined age, gender, weight, height and level of physical activity consistent with good health. In children and pregnant and lactating women, the EER is taken to include the needs associated with the deposition of tissues or the secretion of milk at rates consistent with good health.
Acceptable Macronutrient Distribution Range (AMDR)	The range of healthful intakes for carbohydrate, fat and protein, expressed as a percentage of total energy intake. These ranges were set at amounts determined to reduce the risk of chronic diseases, such as obesity, heart disease, diabetes and cancer.

The scientific data used to develop the DRIs have come from observational and experimental studies, with studies published in peer-reviewed journals being the principle source of data [12]. The RDA's are also divided into several different life stage groups based on significant life events. Therefore, for the purpose of this thesis, the RDA reference values used will be those for male and female adolescents age 14-18 years, and in some instances, young adulthood 19-30 years. There are also several limiting factors that must also be taken into consideration when using the DRIs. The DRIs apply to healthy individuals and therefore are not intended for people who are malnourished, who have a disease that alters nutrient needs, or those that may have higher nutrient needs such as athletes [15]. The DRIs also represent average intakes, and the intakes of individuals vary from day to day [15]. For the purpose of this thesis the RDAs and AMDRs will be used to gage the average amount of a macronutrient and micronutrient that an individual is consuming.

2.1.3 Assessing dietary intake

Assessment of dietary intake is an important aspect to acknowledge while considering the effects that the diet may have on health and disease. There are several techniques that are used to assess dietary intake, including: dietary history, 24-hour recall, food records (3 and 7 day being most common) as well as food frequency questionnaires (FFQ) [16-18]. Each technique presents itself with a unique set of strengths and weaknesses. Dietary history is a widely accepted

technique and includes the long-term history or pattern of usual intake. However, this technique requires an extensive interview performed by a trained nutritionist and may not be feasible for everyone [16]. In comparison, the 24-hour recall can be performed by an individual with much less training and in a shorter amount of time [16]. The subject is asked to recall exact dietary intake within the last 24 hours. The major weakness with this method is that memory of recent intakes may not be completely accurate. Also, diets may vary greatly from day to day and may not be a true representation of average dietary intake [16]. A more common approach is a food record in which all foods are written down with weighing, measuring and estimating portion sizes. This method is used often in research, but it demands a large amount of cooperation from the subjects and inaccurate reporting, including underreporting and over reporting may pose an issue [16]. The main method of interest in this thesis is the FFQ. FFQs have advantages over other dietary assessment methods, because they are relatively inexpensive and can measure long-term dietary intake, especially for large population samples [18-20]. A FFQ includes questions on commonly eaten foods that cover the entire diet, plus additional questions to adjust for fat, protein, carbohydrate, sugar, and whole grain content [21]. As well, the reliability and validity of a FFQ to determine dietary intake patterns has been tested in specific populations, such as a Western population [22], a Japanese population [23] and a population of Swedish women [21]. The Block FFQ has also been specifically tested for reliability and validity in Canadian women by comparing the Block FFQ to

multiple 24-hour dietary recalls and a secondary FFQ [24]. This study found high correlations between both the FFQ and 24-hour dietary recalls at different time points for both macronutrients and micronutrients, and therefore the Block FFQ can be considered a reliable and valid measurement of dietary intake in this population [24].

2.1.4 Macronutrients

2.1.4.1 Carbohydrates

Carbohydrates are a class of organic molecules that are made from carbon, hydrogen and oxygen to form a carbohydrate or a sugar. The primary role of carbohydrates (sugars and starches) is to provide energy to cells in the body [12]. There are four categories of carbohydrates including monosaccharides, disaccharides, oligosaccharides and polysaccharides. The number of simple sugars linked within the molecule distinguishes each carbohydrate type. Monosaccharides represent the basic unit of carbohydrates and include glucose, fructose and galactose as the nutritionally important monosaccharides [10]. When two monosaccharide molecules are combined, they form a disaccharide. Monosaccharides and disaccharides are both commonly referred to as simple sugars [10]. Each disaccharide contains glucose as a principle component. The three disaccharides include: sucrose, lactose and maltose. Both, oligosaccharides and polysaccharides are referred to as complex carbohydrates. Oligosaccharides form from combining three to 10

monosaccharide residues and are often breakdown products of polysaccharides [9]. Polysaccharides refer to the linkage of 10 to thousands of monosaccharide residues. Monosaccharides can be further classified into both plant and animal categories. Animal polysaccharides include glycogen while plant polysaccharides include both starch and fibre [9]. Carbohydrates may also be refined or in their natural state [10]. Examples of foods that contain unrefined or carbohydrates that remain in their natural state include whole-grain bread, fresh fruit and milk because they have not been processed or altered and contain naturally occurring vitamins and minerals [10]. In comparison, refined carbohydrates usually only provide digestible carbohydrates and the amount of vitamins, minerals and dietary fibre is greatly reduced while the amount of sugar, fat and salt may be increased [10].

Fibre is classified as a non-starch, structural polysaccharide. Fibres can differ widely in physical and chemical characteristics and physiological action. They are located mostly within the cell walls of plant foods as cellulose, gums, hemicellulose, pectin and the noncarbohydrate lignins that provide rigidity [9]. Fibre can then be further classified into three categories: dietary fibre, functional fibre and total fibre. Dietary fibre consists of non-digestible carbohydrates and lignin that are intrinsic and intact in plants. Functional fibre consists of isolated, non-digestible carbohydrates that have beneficial physiological effects in humans. Functional fibres can be added to other foods. Total fibre is the sum of dietary fibre and functional fibre within a food [12]. Dietary fibre intake has no

RDA, however it does have an AI that is 26g/d and 25g/d for females aged 14-18y and 19-30y, respectively. For males, the AI for fibre is 38g/d for both males aged 14-18y and 19-30y [25].

To date, there is a lot of discussion on dietary carbohydrate intake and weight gain [26]. It was previously thought that the main culprit for an increase in the prevalence of obesity was mainly due to an increase in dietary fat [26]. Interestingly it has been shown that although there has been a decrease in the reported daily intake of fat, the prevalence of obesity has continued to rise [27]. This suggests that dietary fat intake may not be entirely responsible for this increase in weight gain [26]. In a typical Western diet, carbohydrate intake has increased while dietary fat intake has been reduced thus causing carbohydrate foods (particularly those that are refined) to become an issue by providing large amounts of quickly digested starches and sugars, with the potential to increase serum triglycerides and reduce HDL-cholesterol [28]. This is mainly due to the notion that when dietary fat intake is decreased, there is usually a compensatory increase in dietary carbohydrate intake to help maintain total energy intake [28]. It has been shown that replacing intakes of saturated fat with carbohydrates increases the risk of non-fatal myocardial infarction since most carbohydrates in typical western diets are typically highly processed and are also foods with high glycemic loads [29]. High-carbohydrate diets with a high proportion of refined, high glycemic index carbohydrates will act to stimulate insulin secretion and thus inhibit fat oxidation and promote fat storage [14]. This excessive postprandial

insulin secretion may lead to health complications including weight gain and type 2 diabetes [14]. However, low glycemic index/load carbohydrates that are more slowly digested, less readily absorbed and fermentable may promote weight loss as well as weight loss maintenance [14]. Therefore, there is a relationship between high carbohydrate diets, namely high glycemic index and refined carbohydrates and their role in weight gain, increased fat storage and increased risk of obesity related disorders [14]. From a FFQ, we can get information on total carbohydrate intake (monosaccharides, disaccharides, etc.) (g), fibre intake (g) also total sugars and starch, as well as the carbohydrate percent of total calories. One study in first-year students assessing information from a FFQ found that the percentage of students eating wheat products more than once per day increased from 13.0% to 24.4% [3]. This increase in daily carbohydrate intake could account for overall increases in body weight and body fat percent and is therefore a focus in this thesis.

An inverse relationship exists between dietary fibre intake and body weight [30]. Epidemiological and cohort studies have consistently revealed that higher fibre intakes are correlated with lower body weight, BMI, waist circumference, improved plasma lipid profiles and improved glycemia and insulinemia, CVD and type 2 diabetes in adults [31]. Dietary fibre has implications for health as high intakes of fibre have also been linked to a decreased risk of the metabolic syndrome [9]. The metabolic syndrome is a cluster of risk factors for cardiovascular disease and type 2 diabetes mellitus that include: raised blood

pressure, dyslipidemia (raised triglycerides and lowered high-density lipoprotein cholesterol), raised fasting glucose and central obesity [32]. There are several physiological mechanisms that facilitate body-weight control with increased fibre intake. The first is that fibre-rich foods tend to be more satiating due to their lower energy density as compared with low-fibre foods such as digestible polysaccharides and simple sugars [33]. Fibre rich foods may also increase meal duration and mastication. These effects would increase satiety and delay gastric emptying which also affects the glycemic response after a meal [30]. Secondly, dietary fibre, especially soluble fibre increases the viscosity of diets and slows down the digestive process by increasing bulking and gel formation of gastric contents [33]. Lastly, dietary fibre could provide a mechanical barrier to the enzymatic digestion of other macronutrients such as fat and starch in the small intestine [33]. Dietary fibre in children and adolescents has also been shown to play a protective role against excess adiposity (lower waist circumference) and metabolic disorders [34]. Please refer to Table 2 for full RDA and AMDR values for each nutrient.

2.1.4.2 Fat

Fats or lipids, are the general term for a group of compounds that includes oils, fats, waxes and related compounds. Lipids can be generally classified into three major groups: simple lipids, compound lipids and derived lipids. Simple lipids consist primarily of triacylglycerols. They are the most plentiful fats in the

body and are stored in adipose tissue. Triacylglycerols are made from one alcohol molecule (glycerol) attached to three fatty acid (FA) molecules. FAs are naturally occurring dietary constituents that have extensive metabolic, structural and functional roles within the body. They are important sources of energy, major components of cell membranes and precursors to signaling molecules [35]. FAs can be classified into saturated fatty acids (SFA) and unsaturated fatty acids which includes both monounsaturated (MUFA) and polyunsaturated fatty acids (PUFA). SFAs contain single covalent bonds between the carbon atoms. They are referred to as saturated because they hold as many atoms as chemically possible. This type of FA is primarily found in animal products [9]. Unsaturated FAs contain one or more double bonds along the main carbon chain. MUFA contain one double bond while PUFA contain two or more double bonds. Within the PUFA family there are also omega-3 (n-3) and omega-6 (n-6) PUFAs [36]. Mammals are unable to synthesize n-3 and n-6 PUFAs due to a lack of necessary enzymes. Therefore, docosahexaenoic acid (DHA), eicosapentaenoic acid (EPA), α-linolenic acid (ALA) and linoleic acid (LA) are essential PUFAs that must be obtained in the diet. Between them, LA and ALA constitute over 95% and perhaps even as much as 98% of dietary PUFA intake in most Western diets [35]. ALA and LA are also substrates for the synthesis of long chain PUFAs. From ALA (n-3 FA) you can synthesize EPA and DHA [36] and from LA (n-6 FA) you can synthesize arachidonic acid (AA) [36], although humans cannot easily synthesize these long chain PUFAs [35]. In typical Western diets, 20-25 fold

more n-6 PUFA than n-3 PUFAs are consumed [37]. The increased intake of n-6 PUFA are due to the abundance of LA that is present in high concentrations in soy, corn, safflower and sunflower oils [37]. In contrast, there is a low intake of n-3 PUFA namely ALA which is present mainly in leafy green vegetables as well as in flaxseed and canola oils. Compared to LA, there is also little dietary intake of AA and EPA which are present in both meat and fish, respectively [37].

For the most part, PUFAs from n-6 FA usually exert inflammatory effects while the products from n-3 PUFAs exert anti-inflammatory effects [36]. n-3 PUFAs such as EPA and DHA have been previously shown to be cardioprotective as well as beneficial to neurological health and cancer prevention [38]. PUFAs regulate inflammatory responses mainly through the production of inflammatory mediators termed eicosanoids [39]. Increased intakes of LA (n-6 FA) have been linked to increased rates of diseases involving inflammatory processes such as cardiovascular disease, obesity, cancer and certain psychiatric disorders such as depression [39]. n-3 PUFAs, by comparison, have been shown to exhibit protective effects though anti-inflammatory mechanisms including their ability to inhibit the formation of n-6 PUFA derived eicosanoids [39].

Compound lipids are another large class of lipids. Compound lipids include: phospholipids, glycolipids as well as lipoproteins. Lipoproteins carry cholesterol around the body [10]. Cholesterol is necessary in the body, but because the liver manufactures it, it is not essential in the diet [10].There are two

lipoproteins that are of most interest, low density lipoproteins (LDL) and high density lipoproteins (HDL). These have also been termed the “bad cholesterol” and “good cholesterol” carrying molecules, respectively. LDL carriers between 60-80% of total cholesterol and has the greatest affinity for cells in the arterial wall [10]. LDL delivers cholesterol to arterial tissues, where it can become oxidized and contribute to the increased risk of developing heart disease [9, 10, 40]. In contrast, HDL has a protective effect against heart disease. HDL acts to reverse the transport of cholesterol from the body cells back to the liver where it is either re-incorporated into other lipoproteins, repurposed (e.g. into bile) or excreted [9, 10, 40].

Public dietary recommendations for suggested intakes of macronutrients have been targeting lower fat intakes - specifically cholesterol, saturated fats as well as trans fat as a means to improve the overall health of the population [27]. These recommendations have been based on the assumption that saturated fat intake is associated with risk of the accelerated development of artery disease and premature mortality of heart attack and stroke [27]. Because of these recommendations and guidelines, the intake of dietary dairy fat, for example, has decreased over the past 40 years during which obesity rates have increased [41]. However, lowering overall fat intake may not be the true culprit. Increasing rates of obesity may relate to an increase of refined, high GI dietary carbohydrates, as previously mentioned [41]. Diets that reduce total fat and increase carbohydrate have not been associated with improvements in CVD. In a recent meta-analysis,

there has been no clear association between higher intake of saturated fats and all-cause mortality, CHD, CHD mortality, ischemic stroke or type 2 diabetes among apparently healthy adults [29]. In the same study, there was also no significant associations found with increased saturated fat intake in relation to the major causes of death such as colon and breast cancer [29].

Information provided by a FFQ includes total dietary fat intake (g), saturated fat intake (g), MUFA (g) and PUFA (g) as well as total cholesterol (mg). In a previous study of first-year university students, it was shown that the percentage of students consuming fish at least once per day had decreased from 10.7% to 0% [3]. This decrease in fish consumption greatly decreases the amount of PUFA intake in these students. It was also shown that other fat containing sources such as margarine and animal fat eaten at least once per day had increased from 37.8% to 60.9% and 17.1% to 23.8%, respectively [3]. Please refer to Table 2 for full RDA and AMDR values for each nutrient.

2.1.4.3 Protein

Proteins are made up of groups of amino acids joined together by peptide bonds. Protein is required in the diet to maintain body nitrogen and a supply of indispensable amino acids owing to losses during protein turnover [42]. There are 20 different amino acids required by the body, some of these are essential and some are non-essential. The body does not have the capability to synthesize the eight essential amino acids, so they must be ingested in food. These include:

isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine. With an increasing prevalence of obesity and metabolic disorders, many studies have focused on dietary protein, weight loss and the prevention of weight (re)gain [43]. Protein may be useful for weight control because, compared to the other macronutrients it can increase diet-induced thermogenesis and satiety [43]. Foods containing proteins can be further classified as “complete” versus “incomplete”. This refers to the amount of essential amino acid within each of the protein foods. Complete proteins (or high quality proteins) come from foods that contain all the essential amino acids in the quantity to maintain a nitrogen balance. An incomplete protein (low quality protein) lacks one or more essential amino acid [10].

Proteins are an important component of the diet and in a typical Canadian diet provide roughly 15% of energy, typically resulting in intakes twice the RDA [10]. There has been a lot of evidence supporting higher protein diets (greater than 20% of total energy intake) for weight loss and the prevention of weight (re)gain [43]. It is also important to note that higher dietary protein intake may not only increase weight loss, but also promote high quality weight loss where there is a decrease in fat mass but a preservation or increase in lean body mass [44]. This ratio of fat:lean mass loss is not only important for short-term efficacy but also for long term metabolic health and body weight maintenance [44]. This is important to avoid plateaus during weight loss and more importantly to decreases the risk of weight regain. Skeletal muscle also has multiple important roles in the

regulation of glycemia, lipidemia, therefore a decrease in lean body mass may have adverse effects on long-term metabolic health [44]. Information provided by the FFQ will tell us the amount of dietary protein (g), individual amino acids (g), as well as percent of total calories. It is of importance in this thesis as it has previously been shown that the percentage of students consuming meat and meat products more than once per day (12.8% to 25.5%) had doubled in a sample of first-year students [3]. It is therefore of great interest in this thesis to quantify these changes in protein intake and determine if the sources of protein contribute to low or high diet quality. Please refer to Table 3 for RDA and AMDR values for each nutrient.

Table 2: RDA (g/d) and AMDR (%) values per macronutrient per sex and age group

Nutrient	**RDA values Females aged 14-18y**	**RDA values Males aged 14-18y**	**RDA values Females aged 19-30y**	**RDA values Males aged 19-30 y**	**AMDR Values**
Carbohydrate	130	130	130	130	45-65
Fibre	26	38	25	38	-
Total Fat	-	-	-	-	25-35 (14-18y) 20-35 (19-30y)
LA (n-6 PUFA)	11	16	12	17	5-10
ALA (n-3 PUFA)	1.1	1.6	1.1	1.6	0.6-1.2
Protein*	46	52	46	56	10-30 (14-18y) 10-35(19-30y)

**Also expressed g/kg/d: 0.8g/kg/d for adults*

2.1.5 Micronutrients

2.1.5.1 Vitamins

Vitamins are organic compounds required by the body in minute amounts. With the exception of vitamin D, the body cannot synthesize vitamins so they must be obtained through the diet [45]. There are 13 different vitamins that can be classified into two different categories, as either fat soluble or water soluble [45]. Fat soluble vitamins are stored in the body's adipose tissue. Because of this, we do not need to consume these vitamins daily. Fat soluble vitamins are often found in foods that contain fat, for example: fish, nuts and oils [45]. Water soluble vitamins, on the other hand, disperse readily in body fluids, and we do not have the ability to adequately store these vitamins. Therefore, we are required to consume them daily. Decreasing the amount of water soluble vitamins in the diet can result in deficiencies, whereas a decrease in fat-soluble vitamins may only manifest as a symptomatic deficiency after months to years [45]. If there is a surplus in water soluble vitamins due to dietary intake, generally they are excreted in the urine. Water soluble vitamins also act as coenzymes. These are small molecules that combine with a larger protein compound to form an active enzyme that accelerates the inter-conversion of chemical compounds. Coenzymes also act directly in chemical reactions [45]. Information regarding vitamin intake were obtained from the FFQ. For information and functions about each specific vitamin please refer to Table 3.

Table 3: Information on select vitamins [10, 40, 45].

Vitamin	Fat/Water Soluble	Food Sources	Functions
Vitamin D	Fat Soluble	Beef liver, egg yolk, dairy (fortified)	Maintains normal amounts of calcium and phosphorus. Helps the body absorb calcium
Vitamin A (beta-carotene)	Fat Soluble	Dark leafy green vegetables	Maintenance of epithelial tissues and constituent of visual pigment
Vitamin C	Water Soluble	Citrus fruits, tomatoes, green peppers, salad greens	Maintains intercellular matrix of cartilage, bone and dentine. Important in collagen synthesis.
Vitamin E	Fat Soluble	Seeds, green leafy vegetables, margarines, shortenings	Functions as an antioxidant to prevent cell damage
Vitamin B1	Water Soluble	Pork, organ meats, whole grains, nuts, legumes, milk, fruits, vegetables	Coenzyme in reactions involving the removal of carbon dioxide
Vitamin B2	Water Soluble	Meats, eggs, milk products, whole-grains, wheat germ, green leafy vegetables	Constituent of two flavin nucleotide coenzymes involve in energy metabolism
Niacin	Water Soluble	Liver, lean meats, poultry, grains, legumes, peanuts	Constituent of two coenzymes in oxidation reduction reactions
Folate	Water Soluble	Legumes, green vegetables, whole-wheat, meats, eggs, milk products, liver	Coenzyme involve in transfer of single-carbon units in nucleic acid and amino acid metabolism

Vitamin B6	Water Soluble	Meats, fish, poultry, vegetables, whole-grain, cereals, seeds	Coenzyme involved in amino acid and glycogen metabolism

Some of these vitamins are also antioxidants (e.g. vitamin A, beta-carotene, vitamin C and vitamin E). Antioxidants help reduce the damage caused by free-radicals. Free radicals are highly reactive atoms, molecules or molecular fragments that contain at least one unpaired electron in its outer valence shell [45]. It is important to consume antioxidants in the diet because they function to inhibit the oxidation of other molecules thereby decreasing the likelihood of cellular damage or oxidative stress [46].

2.1.5.2 Minerals

Minerals are also classified as micronutrients. They consist of a group of 22 mostly metallic elements. Minerals serve as constituents of enzymes, hormones and vitamins; they combine with other chemicals or can exist on their own [45]. There are seven major minerals (required in amounts >100mg) and 14 minor or trace minerals (required in amounts <100mg). Most minor and major minerals occur freely in nature and are obtained through the diet. For more information and functions of these minerals, please refer to Table 4.

Table 4: Information on select minerals [10, 40, 45]

Mineral	Major/Minor	Food Sources	Functions
Calcium	Major	Milk, cheese, dark green vegetables, dried legumes	Bone and tooth formation, blood clotting, nerve transmission
Zinc	Minor	Widely distributed in foods	Constituent of enzymes involved in digestion
Iron	Minor	Eggs, lean meats, legumes, whole grains, green leafy vegetables	Constituent of hemoglobin and enzymes involved in energy metabolism
Potassium	Major	Leafy vegetables, cantaloupe, lima beans, potatoes, bananas, milk, meats, coffee, tea	Fluid balance, nerve transmission, acid-base balance
Sodium	Major	Common salt	Acid-base balance, body water balance, nerve function
Magnesium	Major	Whole grains, green leafy vegetables	Activates enzymes involved in protein synthesis.

Minerals can have three broad functions within the body: 1. Provide structure in forming bones and teeth; 2. Maintain normal heart rhythm, muscle contractility, neural conductivity and acid-base balance; 3. Regulate metabolism by becoming constituents of enzymes and hormones that modulate cellular activity [40]. Sometimes, the same mineral from different foods may not be absorbed to the same extent. For example, spinach contains a considerable amount of calcium but the body is only able to absorb roughly 5% of that calcium,

whereas calcium from milk is more easily absorbed [9]. This is due because the small intestine can readily absorb minerals from animal products but is not as good at absorbing minerals from plants because plant binders (e.g. phytates, oxalates) and dietary fibre hinder their absorption [45];

2.2 Weight Gain During University

2.2.1 Changes in Body Weight and Body Composition

Throughout the lifespan there are critical periods in which weight gain is more likely [47]. Young adults experience rapid growth and alterations in accumulation and location of fat mass and may also adopt behaviours during this time that are often associated with an unhealthy lifestyle and poorer overall health [48]. Lifestyle changes that may prompt or encourage weight gain include co-habiting, getting married as well as going to college/university [49]. Not only is the accumulated of fat hard to lose, but also the behaviours established during this critical period, shape lifestyle choices made in the future [48]. This supposed weight gain during first-year college/university is commonly referred to as the "freshman 15". The phenomenon was created by the popular media and refers to the notion that first-year students will gain roughly 6.8kg (15lbs) during their first-year at university [6]. Despite its pervasiveness in the popular media, only a small number of studies to date have examined the "Freshman 15" weight gain, and most report less than 15 pounds of gain [6].

Weight gain during first-year university is assumed to result from several changes in lifestyle associated with being at university including: transition to a more sedentary lifestyle, exposure to more social eating occasions, greater access to less healthy cafeteria and fast-food meals, increased engagement in social drinking, and hormonal disturbance from reduced sleep or stress [48]. Many students also live without parental supervision for the first time and must make independent health-related decisions. Students may also have some difficulty maintaining or incorporating physical activity into their new daily routines on top of establishing a healthy diet [50]. The most common reasons suggested to affect food choices in this young population include changes in living arrangements, increased costs with less financial resources, as well as increased availability of convenience and fast foods [2].

There are many inconsistencies in the literature regarding the magnitude of weight change during the transition to university life. The majority of students incur some type of weight gain, but, it seems, not nearly as much as 6.8kg (15lbs) [48]. Actual average weight gain has been shown to be anywhere from 0.73 kg to 4 kg (8.8lbs) [4]. Some studies have even found no significant weight gain in the first-year of college [4, 51, 52]. One factor that may contribute to these mixed results is the fact that these “Freshman 15” studies have been carried out by researchers in different universities, and university disciplines/departments with little standard methodology for measuring freshman weight gain [4]. Most studies tend to be limited by relatively small sample sizes, high attrition rates,

lack of quantitative data on dietary intakes, and, for the most part, no separation of data by sex [7]. Many other studies rely on self-reported height and weight values which tend to be underreported by participants [4]. On the other hand, some studies have found a firm basis for first-year weight gain. One study compared women attending a university to aged-matched women attending a community college and found that the women who were in university had gained approximately 0.3kg (0.7lbs) per month over the course of 8 months, compared to that of 0.01kg (0.02lbs) of those attending community college. This represents a rate of weight gain in the female university students that is 36 times greater than those attending college, albeit still a small gain [53].

A recent meta-analysis found weight gain during first-year to be anywhere from 0.73kg (1.6lbs) to 4kg (8.8lbs) and some studies have even found that no significant weight gain occurs in the first-year of university [4]. Although the weight increases seen in these studies are generally modest changes when compared to the original thought of 6.8kg (15lbs), this modest weight gain could continue across the lifespan and put individuals at risk for chronic diseases including metabolic syndrome as they age.

2.2.2 Dietary Changes

Changes in dietary intake and eating habits can play a large role in first-year weight gain [3]. One of the great challenges that students face when transitioning from high school to university is establishing their own version of a

healthy diet. Students have access to unhealthy food choices on campus, such as fast-food and foods found in dining halls that offer unlimited portions [54]. Weight gain during the first few months of college/university is most likely caused by a combination of factors which lead to positive energy balance. For example, energy intake increases because of a change in eating habits. Students begin to eat in buffet style, all-you-can-eat dining halls, consume larger portion sizes and consume a large amount of pop. Additionally, eating hours become more erratic and alcohol intake increases [55]. It has also been shown that many college students practice unhealthy lifestyles above and beyond their eating habits, placing them at risk for developing serious health problems. Unhealthy dietary behaviour is only one of the six top health risk behaviours identified in college students [56, 57]. The others include decreased physical activity, increased alcohol intake and smoking and higher stress levels [57]. This may be due to the fact that, for the most part, young adults often lack the experience of food shopping, preparation and planning meals, and must begin all of these tasks at the same time during their first-year at university [2]. It is also possible that these young students have very little knowledge of what a healthy diet consists of. Even among students who do have an idea of what a healthy diet consists of, it has also been shown that when college students leave home and adjust to independent living, good dietary habits decline and poor dietary habits tend to get worse [57].

Similar to studies that quantify the amount of weight gain that occurs, there are also differences in the literature regarding how dietary habits and intakes change over the course of first-year of university studies and how this affects overall health. One study found drastic changes in dietary intake and eating habits from the beginning to the end of first-year university. In this study of 47 students (mixed males and females), there was almost a two fold increase in the percentage of students who consume wheat and meat products, increases in the proportion of students who consumed sugar, milk, margarine and a decline in the percentage of students who consume fish, dark-green leafy vegetables, indigenous vegetables and fruits [3]. Another study that looked at type of snack foods purchased at university cafeterias found that as each semester proceeded, students bought more unhealthy snack foods, representing roughly 44% of total purchases as compared to only 22% for healthy snack foods [58]. This can contribute to an increase in total energy intake as well as an increase in saturated fat and refined/processed carbohydrates, and a decrease in micronutrients.

Other studies have found no change in dietary intake for both energy and macronutrients over the course of first-year. One study that included 116 healthy female first-year students at a Guelph University, found no significant changes in either energy intake or total macronutrients [7]. However, this study had used 24-hour dietary recalls as a method to assess dietary intake and this may not be sufficient enough to detect overall changes during the course of a whole year.

Another study based at the same Canadian university found that, in 128 male first-year students, there was also no significant differences in intake of energy or nutrients including protein, carbohydrate, dietary fibre, total fat, saturated fat, cholesterol, calcium, iron, sodium and zinc over the course of first-year [8]. This study had again used 24-hour dietary recalls as the main source of information on dietary intake. As a comparison, another study that had used a FFQ to quantify these changes found considerable decreases in fruits and vegetables consumption, but also decreases in energy, protein and fat intakes in 54 females who had also gained weight. It was also found that these females increased their carbohydrate intake and decreased their physical activity, which may explain the increase in body weight [59].

First-year students are not only at risk for increasing or decreasing nutrient intake, but also decreasing overall diet quality [60, 61]. Diet quality is an umbrella term that is frequently used to describe how well an individual's diet conforms to dietary recommendations, while providing correct amounts of dietary energy and all essential nutrients [62]. Diet quality can be assessed by using the healthy eating index (HEI) and the diet quality index (DQI); measures developed and used primarily in the United States [63-66]. Previous studies have also assessed diet quality less objectively and on the basis of current knowledge of foods, food groups, nutrients and dietary habits that are associated with increased or decreased risk of disease [67, 68]. First-year students are likely at risk for decreasing diet quality due to the greater availability of and increased reliance on

foods that are more energy-dense and nutrient-poor such as fast food, fried food and processed food. As well, students may decrease their intake of fruit and vegetables because they are less available and/or more expensive [7, 61, 69]. Previous studies show that first-year students also display increases in alcohol intake during their first-year in university which can drastically add to this decrease in diet quality [7, 8, 70].

2.2.3 High-Sugar Beverages and Alcohol Intake

Beverages represent one of the portions of our diet that individuals tend to forget and are also significant contributors to added calories and sugar. Beverages that are sweetened with high fructose corn syrup (HFCS) are linked to increased energy intake and weight gain [71]. Added sweeteners and sugars in our beverages contribute energy to our total dietary intake and represent roughly 318 kcal/d for the average American [71]. HFCS is added to many popular beverages consumed by first-year student including: carbonated beverages, soft drinks, fruit drinks and energy drinks [71]. Evidence suggests that the increased consumption of HFCS as well as sugar in beverages may be linked to an increase in obesity later in life [5]. Moreover, it has been shown that there is a significant positive relationship between obesity/overweight and frequent consumption of carbonated drinks, tea and coffee [5]. Additionally, individuals consuming high amounts of these sugared drinks may gain weight despite decreasing the consumption of other food items [5].

Increases in alcohol consumption is another lifestyle change that many first-year students experience [7, 8, 70]. Alcohol is considered to be a prominent part of the college and university culture. It is present at most social functions and is part of many peer interactions [72]. Unhealthy alcohol use in the first-year at university can range from risky drinking through to abuse and dependence [73]. 44% of college students report one or more heavy drinking episode in a two-week period, while 37% of first-year students meet criteria for alcohol abuse or dependence [73]. Alcohol itself is the second most energy-dense macronutrient and has an appetite-enhancing effect, both of which may lead to an increase in energy intake [74]. Studies have shown that there is a significant positive association between consumption of alcohol and BMI, with frequent consumption of beer and alcoholic beverages other than wine being significant predictors of overweight and obesity [5]. Problematic alcohol use is more prevalent among university students compared to individuals who obtain jobs following graduation from high school [72]. Furthermore, individuals entering college/university who live on campus or away from home show marked increases in alcohol use, compared with those who live at home [72]. Part of the reason for weight gain with increased alcohol consumption is that moderate alcohol drinkers do not compensate for the increase in energy intake by decreasing the amount of energy provided by non-alcohol foods. Therefore, they tend to have higher energy intakes than non-drinkers [74]. It has also been shown that alcohol may suppress the oxidation of fat (favouring fat storage) which may also lead to

weight gain and an increase in BMI in individuals who consume alcohol [74]. There have also been studies linking alcohol intake to an increased waist to hip ratio [74]. Thus, increased alcohol intake promotes an increase in adipose tissue stores that tend to put people at a higher risk for obesity and its related disorders [75].

2.2.4 Sex

There has been some research on how sex may play a role in first-year weight gain. Although men generally have higher BMIs (usually a reflection of increased muscle mass) than women at college or university, previous research is mixed on whether men or women are more likely to gain weight or not [50]. Previous studies have focused solely on weight gain in women, however when men were included in the sample, it was shown that men gained significantly more weight than women (specifically 1.7kg (3.7lbs) for men versus 0.8kg (1.7lbs) for women) [53]. Furthermore, men have been shown to gain significantly more weight during the first semester of university than women [54], but in other work, no significant differences in weight gain were found between sexes during first-year university [76]. Future research is needed to ascertain whether sex differences do exist for weight gain in first-year university, and, as a step further, whether differences exist in the composition of the weight gained between sexes.

2.2.5 Living Arrangements

Another factor that may have an influence on whether first-year students gain weight is their living arrangements while at university. Living arrangements are typical divided into three subgroups: living on-campus, living off-campus and living at home (with parents). It is assumed that students who live on-campus use a meal plan and have prepared food and beverages readily available in the dining hall or cafeteria. Students who live off-campus have to acquire and prepare their own food, and students who live with their parents have to either acquire and prepare their own food or their parents continue to prepare food for them [57]. When university students leave home and adjust to independent living, good dietary habits tend to decline while poor dietary habits tend to increase [57]. It has been shown that students who live off-campus tended to have a BMI that was considered overweight or obese, they smoked more, consumed more alcohol and consumed less fruits, vegetables and dairy products [57]. This was closely followed by students who live on-campus. Finally, it was shown that students who still live with their parents are more likely to have BMIs within the healthy weight range and consume a diet that includes a variety of fruits and vegetables [57]. In another study that compared Greek students who live at home to students who live on campus, there were no significant difference in diets or energy intake [2]. It may be due to the increased availability of fresh fruits and vegetables at school and the healthfulness of the typical Mediterranean diet that many students try to adhere too.

Table 5: Summary of inconsistences in previous literature

Study	*N*	Weight Gain	Method	Dietary Changes
Edmonds et al, 2008 [7]	116 females	⬆ 2.4 kg ⬆ 1.8 %BF	24-hr dietary recall	No significant increases in kcals or macronutrients
Pullman et al, 2009 [8]	108 males	⬆ 3.0 kg ⬆ 0.7 %BF	24-hr dietary recall	No significant increases in kcal, macronutrient and select micronutrients
Takomana and Kalimbira, 2012 [3]	47 males and females	⬆ 8.5 kg N/A	FFQ	Increases in wheat, meat, and milk Decreases in fish, fruits and vegetables
Butler et al, 2004 [59]	54 females	⬆ 0.7 kg ⬆ 1.3 kg FM	FFQ	Decreases in kcals and macronutrients

2.3 Measuring Anthropometry and Body Composition

Anthropometry is one of the most basic tools for assessing nutritional status and overall health [77]. Height and weight measurements are the most practical tools for assessing healthy body weight due to their simplicity and low cost [77]. The most widely used assessment of obesity is body mass index (BMI) with values of $\geq 25 kg/m^2$ considered overweight and $\geq 30 kg/m^2$ considered obese [78]. However, one of the major concerns with using BMI as opposed to other measurements of body composition is the inability to differentiate lean body mass from fat mass [78]. BMI ignores several important factors affecting adiposity including Individuals with greater muscle mass or greater loss of muscle mass and therefore may misclassify individuals as at risk of obesity or not [78]. When used without waist circumference, the use of BMI has been found to result in

incorrectly classifying some individuals due to enhanced muscle mass associated with athletic activities [75]. Therefore, to get an adequate measure of overall health as it relates to body fatness, it is important to use appropriate measurements of adiposity rather than just using a composite measure of weight and height [78].

Most previous research quantifying the weight changes that occur in university students during their first-year have not measured body composition. Therefore, sufficient data are lacking on the actual changes that occur in lean body mass and fat mass during this time, and how this relates to weight change. Usually, only self-reported heights and weights are given and BMI is calculated [53]. In a study comparing men and women, it was found that men had gained significantly more weight, however there were no measures of body composition conducted to assess if the increases were in fat or lean tissue [53]. This variable could ultimately be the difference between weight gained in a positive context rather than a negative context. Therefore, there is a need for studies of this nature to measure specific changes in body composition [4].

2.3.1 Subcutaneous and visceral/intra-abdominal adipose tissue

Excess abdominal fat has been shown to be strongly correlated with increased risk for many obesity related conditions [79]. It has been recognized that increased cardiovascular risk associated with obesity and increased body weight are related more to body fat distribution rather than total body fat. For

example, individuals with upper abdominal, central or android obesity are at a greater risk of all-cause mortality than those with gluteofemoral, peripheral or gynoid obesity [80]. There are two main types of adipose tissue that may accumulate in the abdominal region. Subcutaneous adipose tissue (SAT) is located under the skin, and visceral adipose tissue (VAT) surrounds the internal organs of the viscera, namely the intestines, kidneys, liver, etc. [80]. SAT is the body's large and growing storage area for excess triglycerides [80]. VAT is a smaller storage area directly linked to the visceral organs that is more metabolically adverse [81]. Individuals with higher VAT accumulation have a greater risk of insulin resistance, impaired glucose tolerance, greater inflammation and an overall greater risk of chronic metabolic related disease [80]. The waist to hip ratio (WHR) is a widely-used measure to reflect regional adipose tissue distribution. Waist circumference is defined as the minimal circumference measured at the navel, and hip circumference is defined as the widest circumference measured at the hips and buttocks [81]. Waist circumference, a surrogate anthropometric measure for abdominal/visceral adiposity has been reported to be closely correlated with levels of abdominal fat and therefore is also closely associated with metabolic disorders [81]. WHR combined with BMI improves the utility of the measurement by adding more meaning to the relative risk of an individual of developing certain diseases such as CVD, metabolic syndrome and type 2 diabetes [79].

2.3.2 Bioelectrical Impedance Analysis

The bioelectrical impedance analysis (BIA) device was developed as a method to assess percent body fat (%BF) and body fat mass [79]. BIA can measure specific segments, either the upper body via a hand-to hand device, the lower body via foot-to-foot scales or the right or left sides with electrodes placed on the right or left hand/foot [75]. It can also measure whole body fat at one time by using a device where you stand on a scale embedded with probes on the handles and on the scale so the current can pass through the hands and the feet to get not only a total body scan but also a segmental scan. Research comparing BIA machines to the Bodpod and to dual energy x-ray absorptiometry (DXA), has shown significant correlations between body composition values for each individual modality [75]. However, even though some BIA machines can identify %BF in the abdomen or trunk region, none of the clinical or consumer-grade devices researchers generally use are able to differentiate between subcutaneous and visceral fat in the abdomen [75]. This difference between SAT and VAT, as mentioned above, is very important while determining the effect of fat mass on overall health. When comparing all subjects (male and female) it was shown that the BIA and DXA had no significant difference in measures of %BF [82]. However, among males, BIA overestimated %BF and among females BIA underestimated %BF [82]. When using BIA it is also important to take into account hydration status. Hydration status is important to take into consideration

because the BIA measures the resistance that an electrical current will have travelling through different tissues based on water content [83]. Estimates of fat mass are inaccurate due to hypohydration or hyperhydration [83]. Lean body mass and fat mass are calculated using the measure of total body water based on the concept that the water content of lean body mass is constant and body fat is anhydrous [83]. Therefore, it is important to standardize procedures in regards to hydration prior to subjects using the BIA.

2.3.3 Bodymetrix

The bodymetrix (BMX), is a relatively new device using ultrasound technology to estimate body composition. The BMX estimates fat mass, and fat-free mass by independently identifying adipose tissue compared to muscle and bone mass using ultrasound waves that travel into body tissues [79]. This method is not only practical, but also portable, non-invasive and non-traumatizing to the subject as may be the case with other measures of body composition [79]. It estimates fat mass, and can also measure both subcutaneous and visceral fat layers independently [75]. In a study comparing the Bodpod, BIA and BMX it was shown that all three measure fat mass with equal validity but only the BMX is able to measure visceral fat depth at the same time as it measures fat mass [75]. In other validation studies, a strong correlation ($r = 0.85$) was demonstrated in both males and females for %BF when compared to DXA in a sample of overweight middle aged men and women as well as a moderate correlation ($r =$

0.66) when compared with magnetic resonance imaging and computed tomography in a sample of obese men and women [79]. Another study that had compared the BMX to DXA in high performance athletes found that the BMX produced nearly identical results regardless of sex or the range of %BF in different sports (judo, wrestling, tae kwon do, boxing, rowing) [84]. It is important to note that none of these studies were performed in normal weight participants. The BMX needs to be evaluated in a population of normal-weight, university aged (17-25years) men and women [79].

2.4 Stress

A commonality amongst all college and university students is a feeling of stress. A survey done among in student's attending post-secondary suggested that 30% of students report feeling frequently overwhelmed [85]. This transition into first-year university is a period of increased stress and as such can lead to both weight gain or weight loss. Indirectly, stress may lead to weight change by triggering unhealthy behaviours such as an increase or decrease in dietary intake [86]. In addition, high levels of chronic stress are associated with a number of adverse health effects [85]. This thesis will evaluate weight change as well as changes in eating habits that may include binge eating, disordered eating and overeating [85] and relate these behaviours to measures of stress.

2.4.1 Salivary Cortisol

Cortisol is produced in the adrenal cortex and is the main glucocorticoid hormone in the body. It is released both spontaneously as well as in response to various physical and psychosocial stimuli [87]. Salivary cortisol levels have been shown to be an accurate measure of stress levels in humans, compared to plasma levels of cortisol [87]. Although there are a number of steroid hormones that are affected by stress, cortisol is considered a major indicator of altered physiological states in response to a stressful situation [87]. Cortisol is influenced by circadian rhythm and therefore, in healthy subjects, cortisol is highest in the early morning and lowest around midnight [85]. Since cortisol is a principal mediator of the physiological and psychological stress response, it may play a role in the link between stress and food intake. At times of increased stress, corticotrophin releasing hormone (CRH) is released from the hypothalamus which then triggers the release of adrenocorticotropic hormone (ACTH) from the pituitary which is then followed by the release of glucocorticoids from the adrenal cortex [88]. Glucocorticoids (e.g. cortisol) have been shown to influence food intake such that long-term stress related increases in cortisol causes excess intake of high calorie foods [88]. As well, chronic stressful situations may lead to the avoidance of food in some cases, but more often leads to a desire for energy-dense foods in both human and animal models [89]. It seems to be a trend that when individuals have higher stress levels, they crave more energy-dense, nutrient poor foods such as high fat or salty foods, especially seen in women [88].

In a study done on 14 subjects (both males and females) it was found that subjects with increased cortisol levels (due to an injection of CRH) increased their food intake by 598 kcals/134 grams compared to a placebo group (injected with a saline solution) during a 30-minute sitting period [88]. Sex differences have also been demonstrated with respect to dietary intakes in response to increased cortisol levels [89]. Another study showed that when women are stressed, they tend to increase food consumption and adopt poorer dietary habits more than men [89]. It is thought that these sex differences are due to the relationship between sex hormones and both the basal and stress related HPA axis activity, although this relationship is not yet understood completely [89].

CHAPTER 3: METHODS

3.1 Participants

This study and all related procedures have been reviewed and received ethical clearance from the Brock University Research Ethics Board (REB# 13-297). Potential participants included all incoming, full time, first-year university students aged 17-20 years with no previous university or College attendance.

Recruitment strategies included poster advertisements, flyers, information booths, the media and word of mouth. Recruitment began during the summer (June to August) of 2014 with an information booth at the first-year orientation program at Brock University entitled SmartStart. When the academic year began, we also had an information booth at the BUSU Vendor Fair during the first-year orientation week and gave brief presentations about the study in first-year classes. The study also received media coverage through the Brock University campus news, the Welland Tribune and CHCH news.

After showing interest in the study, participants were emailed an invitation letter (Appendix C-2) which included a thorough description of the purpose, methods and any potential risks of the study. After confirming interest in the study, informed consent was obtained by sending another email with a personalized link to the consent form (Appendix C-1) and a confidential online survey (Appendix B-1 and B-2). After the survey was completed, participants came to the Nutrition Laboratory to complete further measurements. Exclusion

criteria included any student who transferred from a program within Brock or had already completed a first-year at a college or university elsewhere. Compensation for the study included $10 for students who completed both the first and second visits and a bonus 1% class credit in both KINE 1P90 AND PSYC 1F90. The study timeline is depicted in Figure 1.

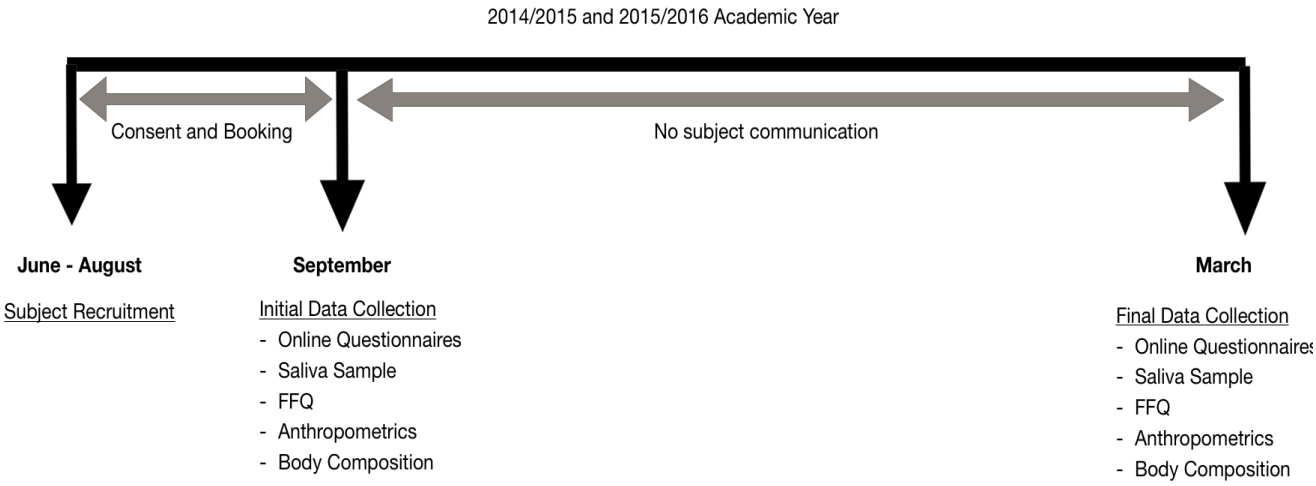

Figure 1: Timeline of study for both the 2014/2015 and 2015/2016 academic year

3.2 Detailed Procedures

Participants were invited to the Nutrition Laboratory for two separate visits. The first visit occurred at the beginning (August/September) of their first-year at Brock University. The second visit occurred at the end (March/April) of the same academic year. Participants were instructed to first complete a series of online surveys prior to coming into the laboratory. Once the surveys were completed, participants were then booked into the nutrition laboratory for the in-person measurements. Participants were instructed to refrain from alcohol for 24 hours

and exercise for 12 hours prior to the testing session for the body composition analyses. Participants were also asked to refrain from eating or drinking anything for 4 hours prior to the testing session for the saliva sample. All visits occurred in the morning to accommodate the fasting of the participants as well to control for the time of day for the salivary cortisol measures. Upon arrival, participants were immediately asked to provide a saliva sample. Afterwards, participants were asked to drink 16 ounces (~500 ml) of water before the body composition measurements. Participants were then given a 127-item food frequency questionnaire (FFQ) (Block 2014, NutritionQuest, Berkeley, CA) (Appendix B-3) to fill out. After the FFQ, height, weight, as well as waist and hip circumference were measured and BMI was calculated. Participants were then asked to void and then had their body composition measured using the BMX System (BodyMetrix™ System, IntelaMetrix, Inc., Livermore, CA, USA). All measurements for the BMX were done in duplicate in order to ensure reliability within participants.

3.3 Measures

3.3.1 Online Survey

Prior to the in-person visit, participants received a confidential link to an individualized online survey via FluidSurveys (FluidSurveys, Ottawa, ON). This online survey was composed of 2 smaller surveys including: a general health and

demographic questionnaire and an eating behaviour questionnaire (Appendix B-1 and B-2).

The general health and demographics questionnaire included information on age, ethnicity, major area of study and living arrangements while attending Brock University. Questions were also included for the participant to describe their commute to Brock. The final component of the general health questionnaire included questions about previous health conditions, medications used, supplements used, smoking habits as well as sleeping habits.

The eating behaviour questionnaire included information on whether the participants ate less or more food based on physical characteristics such as trying to lose or gain weight, and about thoughts and feelings of food and eating. It also included questions about timing of meals such as eating during the day or eating in the evening [90].

3.3.2 Food Frequency Questionnaire

During the in-person visit to the Nutrition Laboratory, completed a FFQ (Block 2014, NutritionQuest, CA, USA). This FFQ included 127 food and beverage items and additional questions to adjust for fat, protein, carbohydrate, sugar and whole grain consumption. The participants were given a portion size sheet to help them quantify the amounts of food that they were eating and to better aid them in answering the questions. This FFQ also included questions on overall energy expenditure over the past 6 months. Participants were asked

during the first visit to fill out the questionnaire based on how they were eating prior to entering university. At the second visit, participants were instructed to fill out the questionnaire based on how they have been eating while at university.

3.3.3 Anthropometric Measures

All anthropometric measures were assessed by the same investigator for all participants. Weight was measured using the 140-10-7N portable fitness scale with no shoes and light clothing (Rice Lake Weighing Systems, Rice Lake, WI). Height was measured with a stadiometer attached to the scale to the nearest 0.1cm with no shoes and light clothing. Body mass index (BMI) was calculated by dividing the participants mass (kg) by their height squared (m^2). Waist and hip circumference (cm) were measured using a standard, retractable, non-metallic tape measure placed at the waist at the level of the umbilicus and across the largest part of the buttocks and below the iliac crest, respectively.

3.3.4 Bodymetrix

Body composition was assessed using the BMX ultrasound device. This device measures fat thickness and calculates percent body fat and mass by scanning at specific landmarks. Gel is applied to the handheld ultrasound device. The device is then placed perpendicular to the skin at specific landmarks and moved a quarter inch to either side of the start position. The Jackson-Pollock

setting was utilized which includes three specific measurement sites for males: thigh, chest and waist, and three for females: thigh, triceps and hip.

3.3.5 Salivary Cortisol Analysis

All saliva samples were taken just as the participants arrived to the laboratory in the morning. Salivettes were used to collect the saliva sample (Sarstedt AG & Co, Numbretcht, Germany). Participants were instructed to insert a cotton swab in their mouths without touching the cotton with their hands. They then chewed the cotton for one minute to stimulate saliva flow. After the cotton was saturated with saliva, it was placed back into the salivette container without touching the cotton to avoid contamination. The salivettes were used to analyze salivary cortisol (ng/ml) levels present in the saliva. All saliva samples were transported on ice and stored at -20 °C prior to assays. Upon study completion, saliva was centrifuged at 3000xg for 15 minutes and only the supernatant was assayed. All enzyme immunoassays were carried out on ELISA (NUNC Maxisorb) plates. Each sample was assayed in duplicate and averages were used. Inter-plate variation (CV) was 6.45% while intra-plate variation was 6.51%. For more information regarding the salivary cortisol analysis please refer to Appendix A.

3.4 Statistical Analyses

Statistical analyses were performed using SPSS version 21.0 for Windows (SPSS, Chicago, Illinois, USA). Descriptive statistics were used to provide information about the overall characteristics of the sample population. All data met all assumptions and outliers were removed and replaced with the series means before continuing the data analysis. Two-way repeated measures ANOVAs were conducted to examine the differences in body weight, BMI, body composition, waist circumference and hip circumference between the first and second time points (TIME/within effect) and between males and females (SUBJECT/between effect). Sub-group analyses included assessing the differences in nutrition, body weight and body composition among different living arrangements and university Faculty. Differences in nutrient intake, grams (g/day) of foods, salivary cortisol and eating behaviors were also analyzed using 2-way repeated measures ANOVAs with the same conditions as above. Food frequency percents and percent changes were calculated based on data about frequency of food consumption from the FFQ. Pearson correlations were performed on the change values for dietary intake (nutrients and foods), eating habits, body composition, anthropometry and cortisol to assess the relationship between them. Significance was assumed below an alpha level of 0.05.

CHAPTER 4: RESULTS

4.1 Descriptives

A total of 301 participants (*n* = 71 males, *n* = 230 females, average age: 18 ± 1 years) completed both the Fall and Spring study visits. A total of 1,272 students expressed interest in the study. During the first cohort (2014-2015) 82 students completed the first visit and 62 students completed the second visit. During the second cohort (2015-2016), 282 students completed the first visit and 239 students completed the second visit. In total 301 participants completed both the first and second visits (*n* = 71 males, *n* = 230 females). Sixty-three students dropped out after the first visit and did not return for the second visit. Thus, our attrition rate was 83%. Table 6 displays subject anthropometric and body composition data at baseline. Sex differences existed for all variables (except age) in Table 6. Females had greater fat mass (kg) and less lean mass (kg) than their male counterparts at baseline ($p < 0.001$). Demographic information about the sample is provided in Table 7.

Table 6: Anthropometric and body composition at baseline

	Males (*n* = 71)	**Females (*n* = 230)**	**p***
Age	18 ± 1	18 ± 1	0.61
Weight (kg)	76.5 ± 11	61.6 ± 11	<0.001
Height (cm)	178.6 ± 7	164.8 ± 6	<0.001
BMI (kg/m2)	24.1 ± 3	22.6 ± 4	0.002
Umbilicus (cm)	81.9 ± 9	78.2 ± 10	0.005
Hip (cm)	99.0 ± 7	96.0 ± 9	0.008
Fat %	12.7 ± 4	25.7 ± 5	<0.001
Lean Mass (kg)	66.8 ± 8	45.2 ± 6	<0.001

Fat Mass (kg)	9.4 ± 4	15.9 ± 6	<0.001

All results are shown as mean ± SD
** Significance from independent samples t-test, significant with P value <0.05*

Table 7: Demographic information

Demographics	***n***	**%**
Cohort		
1 (2014-2015)	62	20.6%
2 (2015-2016)	239	79.4%
Sex		
Males	71	23.6%
Females	230	76.4%
Living Arrangements		
Residence	218	72.4%
Home	65	21.6%
Student House	17	5.6%
Did Not State	1	0.3%
Faculty		
Applied Health Science	136	45.2%
Business	29	9.6%
Mathematics and Science	36	12.0%
Arts (Education, Social Science, Humanities)	100	33.2%

4.2 Anthropometrics and Body Composition

4.2.1 Anthropometrics and Body Composition

Table 8 shows the anthropometric and body composition measures at the beginning of first-year university and at the end, stratified by sex. Both sexes had a significant increase in body weight (kg) with males gaining significantly more weight than females shown by a significant interaction. Males also increased their waist and hip circumference more than females and males gained more lean

mass than females. Furthermore, males and females both gained lean body mass and fat mass (kg) displayed by significant time and groups effects. There was a significant interaction effect for lean body mass such that males gained more than females, which likely accounts for the larger increase in body weight seen in males.

Table 8: Anthropometrics and body composition stratified by sex from the beginning to end of first-year university

	Pre	Post	Group p*	Time p*	Interaction p*
Weight (kg)#			<0.001	<0.001	<0.001
Male (*n* = 71)	76.5 ± 11	80.2 ± 13			
Female (*n* = 230)	61.6 ± 11	63.2 ± 12			
Height (cm)			<0.001	0.10	0.78
Male (*n* = 71)	178.6 ± 7	178.5 ± 7			
Female (*n* = 230)	164.8 ± 6	164.6 ± 6			
BMI (kg/m2)			0.001	<0.001	0.16
Male (*n* = 71)	24.1 ± 3	25.2 ± 3			
Female (*n* = 230)	22.6 ± 4	23.4 ± 4			
Umbilicus (cm)			<0.001	<0.001	0.017
Male (*n* = 71)	81.9 ± 9	84.4 ± 9			
Female (*n* = 230)	78.2 ± 10	79.1 ± 9			
Hip (cm)			0.002	<0.001	0.22
Male (*n* = 71)	99.0 ± 7	100.6 ± 7			
Female (*n* = 230)	96.0 ± 9	96.8 ± 8			
Fat %			<0.001	0.047	0.098
Male (*n* = 71)	12.7 ± 4	12.8 ± 5			
Female (*n* = 230)	25.7 ± 5	26.6 ± 5			
Lean Mass (kg)#			<0.001	<0.001	<0.001
Male (*n* = 71)	66.8 ± 8	69.7 ± 9			
Female (*n* = 230)	45.2 ± 6	46.2 ± 7			
Fat Mass (kg)#			<0.001	<0.001	0.82

Male (*n* = 71)	9.4 ± 4	10.7 ± 5
Female (*n* = 230)	15.9 ± 6	17.3 ± 6

All results are shown as mean ± SD
** Significance from 2-way repeated measures ANOVA (Group: sex; Time: pre to post), significantly different with P value <0.05*
#Discrepancies between reported weight and body composition values are due to the use of different modalities for measuring each (scale vs. BMX, respectively) and the removal of outliers.

4.2.2 Living Arrangements

Table 9 displays the body composition and anthropometric data for males based on those who live in residence (*n* = 55), those who live at home (*n* = 10) and those who live in a student house (*n* = 6). There was a significant group effect for height and no significant interactions. Time effects reflect the changes seen in the whole sample of males (weight, BMI and lean mass increases and a trend towards an increase in fat mass).

Table 9: Anthropometry and body composition of males stratified by living arrangement from the beginning to end of first-year university

	Pre	**Post**	**Group p***	**Time p***	**Interaction p***
MALES (*n* = 71)					
Weight (kg)			0.41	<0.001	0.55
Residence (*n* = 55)	77.4 ± 11	81.3 ± 13			
Home (*n* = 10)	72.2 ± 13	75.5 ± 14			
Student House (*n* = 6)	76.1 ± 12	78.4 ± 13			
Height (cm)			0.029	0.89	0.83
Residence (*n* = 55)	179.8 ± 7	179.7 ± 7			
Home (*n* = 10)	174.1 ± 7	174.3 ± 8			
Student House (*n* = 6)	174.9 ± 4	174.8 ± 5			
Umbilicus (cm)			0.61	0.10	0.42
Residence (*n* = 55)	82.1 ± 9	85.0 ± 9			
Home (*n* = 10)	79.8 ± 8	81.3 ± 10			

Student House (*n* = 6)	83.2 ± 11	83.5 ± 9			
Hip (cm)			0.22	0.098	0.76
Residence (*n* = 55)	99.6 ± 7	101.4 ± 7			
Home (*n* = 10)	95.9 ± 8	97.2 ± 7			
Student House (*n* = 6)	98.2 ± 6	98.7 ± 10			
Fat %			0.29	0.88	0.99
Residence (*n* = 55)	13.0 ± 4	13.1 ± 5			
Home (*n* = 10)	10.9 ± 4	10.8 ± 4			
Student House (*n* = 6)	12.4 ± 5	12.6 ± 4			
Lean Mass (kg)			0.56	0.004	0.81
Residence (*n* = 55)	67.3 ± 8	70.4 ± 9			
Home (*n* = 10)	64.6 ± 12	67.0 ± 11			
Student House (*n* = 6)	66.1 ± 7	68.1 ± 8			
Fat Mass (kg)			0.24	0.061	0.95
Residence (*n* = 55)	9.8 ± 4	11.2 ± 5			
Home (*n* = 10)	7.4 ± 4	8.4 ± 4			
Student House (*n* = 6)	9.2 ± 7	10.3 ± 5			

All results are shown as mean ± SD
** Significance from 2-way repeated measures ANOVA (Group: living arrangement; Time: pre to post), significantly different with P value <0.05*

Table 10 displays body composition and anthropometric data for females who live in residence (*n* = 163), those who live at home (*n* = 55) and those who live in a student house (*n* = 11). There were no significant interactions for any of the body composition measurements. Significant time effects were seen for body weight, and significant group effects were seen for body weight, lean mass and fat mass.

Table 10: Anthropometry and body composition of females stratified by living arrangement from the beginning to end of first-year university

	Pre	Post	Group p*	Time p*	Interaction p*
FEMALES (*n* = 230)					
Weight (kg)			0.017	0.035	0.12
Residence (*n* = 163)	62.9 ± 12	64.8 ± 12			
Home (*n* = 55)	57.9 ± 8	58.7 ± 8			
Student House (*n* = 11)	61.1 ± 8	62.7 ± 9			
Height (cm)			0.25	0.10	0.22
Residence (*n* = 163)	165.3 ± 6	165.0 ± 6			
Home (*n* = 55)	163.4 ± 5	163.5 ± 5			
Student House (*n* = 11)	164.1 ± 6	164.3 ± 6			
Umbilicus (cm)			0.07	0.71	0.80
Residence (*n* = 163)	79.0 ± 10	80.1 ± 10			
Home (*n* = 55)	75.8 ± 9	76.2 ± 8			
Student House (*n* = 11)	77.9 ± 10	79.1 ± 10			
Hip (cm)			0.091	0.86	0.51
Residence (*n* = 163)	96.7 ± 9	97.7 ± 9			
Home (*n* = 55)	93.9 ± 6	94.4 ± 6			
Student House (*n* = 11)	97.2 ± 8	96.3 ± 7			
Fat %			0.084	0.89	0.66
Residence (*n* = 163)	25.9 ± 5	27.0 ± 5			
Home (*n* = 55)	24.6 ± 5	25.3 ± 4			
Student House (*n* = 11)	27.3 ± 6	27.1 ± 6			
Lean Mass (kg)			0.038	0.22	0.61
Residence (*n* = 163)	45.8 ± 6	46.9 ± 7			
Home (*n* = 55)	43.6 ± 5	44.0 ± 6			
Student House (*n* = 11)	44.2 ± 4	45.1 ± 5			
Fat Mass (kg)			0.019	0.35	0.82
Residence (*n* = 163)	16.5 ± 6	18.1 ± 7			
Home (*n* = 55)	14.0 ± 5	15.1 ± 4			
Student House (*n* = 11)	16.4 ± 6	17.4 ± 5			

All results are shown as mean ± SD

** Significance from 2-way repeated measures ANOVA, (Group: living arrangement; Time: pre to post), significantly different with P value <0.05*

4.2.3 Faculty

Table 11 displays body composition and anthropometrics for males stratified by Faculty. There were significant time effects for body weight, BMI, umbilicus circumference, hip circumference, lean mass and fat mass (kg) across Faculties. There are significant interactions for height and hip circumference. However, when looking at pairwise comparisons for both height and hip circumference there were no significant differences between the groups. No significant group effects were seen.

Table 11: Anthropometry and body composition of males stratified by Faculty from the beginning to end of first-year university

	Pre	Post	Group p*	Time p*	Interaction p*
MALES (*n* = 71)					
Weight (kg)			0.63	<0.001	0.62
AHS (*n* = 36)	75.4 ± 10	79.4 ± 11			
Arts (*n* = 10)	80.4 ± 13	84.9 ± 15			
Business (*n* = 14)	75.5 ± 13	78.6 ± 15			
Math and Science (*n* = 11)	78.0 ± 15	80.8 ± 15			
Height (cm)			0.61	0.91	0.049
AHS (*n* = 36)	179.4 ± 8	179.2 ± 8			
Arts (*n* = 10)	176.0 ± 5	175.9 ± 4			
Business (*n* = 14)	179.4 ± 6	178.7 ± 6			
Math and Science (*n* = 11)	177.4 ± 8	178.4 ± 8			
Umbilicus (cm)			0.38	0.001	0.095
AHS (*n* = 36)	80.4 ± 7	83.4 ± 8			
Arts (*n* = 10)	84.5 ± 12	89.8 ± 11			
Business (*n* = 14)	81.9 ± 11	82.8 ± 11			
Math and Science (*n* = 11)	84.2 ± 10	84.6 ± 9			

Hip (cm)			0.19	0.013	0.039
AHS (*n* = 36)	97.0 ± 6	99.4 ± 6			
Arts (*n* = 10)	101.2 ± 7	104.6 ± 8			
Business (*n* = 14)	101.0 ± 8	101.2 ± 9			
Math and Science (*n* = 11)	100.6 ± 7	100.0 ± 9			
Fat %			0.07	0.87	0.69
AHS (*n* = 36)	11.6 ± 4	12.1 ± 4			
Arts (*n* = 10)	15.2 ± 3	15.4 ± 5			
Business (*n* = 14)	14.2 ± 6	13.5 ± 6			
Math and Science (*n* = 11)	11.8 ± 5	11.6 ± 4			
Lean Mass (kg)			0.82	<0.001	0.83
AHS (*n* = 36)	66.9 ± 8	70.0 ± 9			
Arts (*n* = 10)	68.1 ± 10	71.6 ± 10			
Business (*n* = 14)	65.5 ± 7	67.4 ± 10			
Math and Science (*n* = 11)	67.0 ± 10	70.2 ± 10			
Fat Mass (kg)			0.21	0.015	0.73
AHS (*n* = 36)	8.6 ± 4	10.1 ± 4			
Arts (*n* = 10)	11.9 ± 4	13.5 ± 6			
Business (*n* = 14)	9.9 ± 5	11.1 ± 7			
Math and Science (*n* = 11)	9.5 ± 5	9.7 ± 5			

All results are shown as mean ± SD
** Significance from 2-way repeated measures ANOVA, (Group: Faculty; Time: pre to post), significantly different with P value <0.05*

Table 12 displays the body composition and anthropometric measures for females stratified by Faculty. There were significant time effects for body weight, BMI, body fat percent, lean mass and fat mass across Faculties. There were no group effects or interaction effects seen in any of the body composition and anthropometric variables.

Table 12: Anthropometry and body composition of females stratified by Faculty from the beginning to end of first-year university

	Pre	Post	Group p*	Time p*	Interaction p*
FEMALES (*n* = 230)					
Weight (kg)			0.38	<0.001	0.80
AHS (*n* = 100)	61.2 ± 9	62.6 ± 10			
Arts (*n* = 90)	61.4 ± 11	63.1 ± 11			
Business (*n* = 15)	59.5 ± 12	61.6 ± 11			
Math and Science (*n* = 25)	65.1 ± 16	66.7 ± 17			
Height (cm)			0.22	0.077	0.40
AHS (*n* = 100)	165.1 ± 6	164.8 ± 6			
Arts (*n* = 90)	164.0 ± 6	163.9 ± 6			
Business (*n* = 15)	163.9 ± 6	163.4 ± 6			
Math and Science (*n* = 25)	166.5 ± 7	166.5 ± 7			
Umbilicus (cm)			0.59	0.15	0.12
AHS (*n* = 100)	77.4 ± 9	79.0 ± 9			
Arts (*n* = 90)	78.3 ± 10	79.0 ± 10			
Business (*n* = 15)	77.0 ± 10	77.9 ± 9			
Math and Science (*n* = 25)	81.3 ± 12	80.5 ± 12			
Hip (cm)			0.16	0.19	0.52
AHS (*n* = 100)	95.0 ± 8	96.2 ± 7			
Arts (*n* = 90)	96.1 ± 9	96.9 ± 8			
Business (*n* = 15)	95.8 ± 9	96.2 ± 7			
Math and Science (*n* = 25)	99.9 ± 11	99.6 ± 13			
Fat %			0.34	0.027	0.85
AHS (*n* = 100)	25.0 ± 5	25.9 ± 5			
Arts (*n* = 90)	26.0 ± 5	27.2 ± 5			
Business (*n* = 15)	26.6 ± 7	26.9 ± 6			
Math and Science (*n* = 25)	26.2 ± 7	27.0 ± 6			
Lean Mass (kg)			0.092	<0.001	0.48
AHS (*n* = 100)	45.5 ± 5	46.0 ± 6			
Arts (*n* = 90)	44.6 ± 5	45.8 ± 6			
Business (*n* = 15)	43.2 ± 5	44.5 ± 6			
Math and Science (*n* = 25)	47.4 ± 8	48.9 ± 10			

Fat Mass (kg)			0.41	<0.001	0.61
AHS (*n* = 100)	15.5 ± 5	16.6 ± 5			
Arts (*n* = 90)	15.9 ± 6	17.7 ± 6			
Business (*n* = 15)	15.7 ± 7	16.9 ± 6			
Math and Science (*n* = 25)	17.4 ± 9	18.9 ± 9			

All results are shown as mean ± SD
** Significance from 2-way repeated measures ANOVA, (Group: Faculty; Time: pre to post), significantly different with P value <0.05*

4.3 Nutritional Intake

4.3.1 Select Nutrients and Caffeine

Table 13 displays the nutrient and caffeine intake of both males and females from the beginning of the study to the end of the study. Both sexes had a significant decrease in total energy intake as well as decreases in many other nutrients. Interactions were present for carbohydrates, fibre, total sugars, vitamin A (RAE), vitamin D, thiamin, riboflavin, vitamin B6, zinc, iron, potassium, magnesium, vitamin B12, copper and total folate. For these nutrients, males displayed greater decreases than females. Despite a total reduction in energy intake, caffeine intake did not significantly change, and alcohol intake significantly increased in both sexes displayed by a significant time and group effect.

Table 13: Select nutrient and caffeine intakes stratified by sex from the beginning to end of first-year university

	Pre	Post	Group p*	Time p*	Interaction p*
Calories (kcal)			<0.001	<0.001	0.48
Male (*n* = 71)	2711± 1116	2270 ± 949			
Female (*n* = 230)	1850 ± 713	1476 ± 519			
Fat (g)			<0.001	<0.001	0.61

Male (*n* = 71)	104.1 ± 40	88.3 ± 36			
Female (*n* = 230)	72.9 ± 31	59.1 ± 24			
Saturated Fat (g)			<0.001	<0.001	0.32
Male (*n* = 71)	34.4 ± 14	28.9 ± 13			
Female (*n* = 230)	24.0 ± 10	19.8 ± 8			
Monounsaturated Fat (g)			<0.001	<0.001	0.34
Male (*n* = 71)	38.6 ± 15	32.9 ± 13			
Female (*n* = 230)	26.1 ± 11	21.8 ± 10			
Polyunsaturated Fat (g)			<0.001	<0.001	0.13
Male (*n* = 71)	23.0 ± 10	18.9 ± 8			
Female (*n* = 230)	15.7 ± 7	13.1 ± 6			
Protein (g)			<0.001	<0.001	0.37
Male (*n* = 71)	109.0 ± 47	88.4 ± 40			
Female (*n* = 230)	69.1 ± 28	52.1 ± 19			
Carbohydrates (g)			<0.001	<0.001	0.007
Male (*n* = 71)	312.9 ± 129	235.6 ± 89			
Female (*n* = 230)	224.7 ± 85	178.6 ± 68			
Cholesterol (mg)			<0.001	0.001	0.36
Male (*n* = 71)	362.5 ± 150	327.3 ± 161			
Female (*n* = 230)	213.7 ± 98	193.7 ± 94			
Fibre (g)			<0.001	<0.001	0.043
Male (*n* = 71)	23.5 ± 10	17.4 ± 8			
Female (*n* = 230)	17.5 ± 7	13.3 ± 6			
Alcohol (ethanol) (mg)			<0.001	<0.001	0.44
Male (*n* = 71)	7.7 ± 13	9.6 ± 10			
Female (*n* = 230)	3.0 ± 4	5.9 ± 6			
Total Sugars (g)			<0.001	<0.001	0.023
Male (*n* = 71)	142.4 ± 68	108.1 ± 49			
Female (*n* = 230)	102.6 ± 44	82.2 ± 36			
Vitamin A RAE (mcg)			<0.001	<0.001	0.005

Male (*n* = 71)	1162.5 ± 575	887.8 ± 452			
Female (*n* = 230)	715.1 ± 297	580.6 ± 266			
Vitamin C (mg)			0.005	<0.001	0.17
Male (*n* = 71)	159.0 ± 88	126.6 ± 73			
Female (*n* = 230)	127.3 ± 74	109.2 ± 71			
Vitamin K (mcg)			<0.001	<0.001	0.093
Male (*n* = 71)	160.0 ± 96	122.4 ± 77			
Female (*n* = 230)	111.5 ± 54	90.0 ± 53			
Vitamin E (mg)			<0.001	<0.001	0.59
Male (*n* = 71)	12.0 ± 5	9.7 ± 4			
Female (*n* = 230)	8.2 ± 4	6.2 ± 3			
Vitamin D (mcg)			<0.001	<0.001	0.04
Male (*n* = 71)	6.8 ± 3	5.0 ± 3			
Female (*n* = 230)	4.3 ± 2	3.2 ± 2			
Thiamin B1 (mg)			<0.001	<0.001	0.002
Male (*n* = 71)	2.4 ± 1	1.8 ± 1			
Female (*n* = 230)	1.6 ± 1	1.2 ± 1			
Riboflavin B2 (mg)			<0.001	<0.001	0.029
Male (*n* = 71)	2.9 ± 1	2.2 ± 1			
Female (*n* = 230)	1.9 ± 1	1.4 ± 1			
Niacin (mg)			<0.001	<0.001	0.31
Male (*n* = 71)	29.1 ± 13	23.9 ± 11			
Female (*n* = 230)	18.4 ± 8	14.4 ± 6			
Vitamin B6 (mg)			<0.001	<0.001	<0.001
Male (*n* = 71)	2.5 ± 1	1.9 ± 1			
Female (*n* = 230)	1.5 ± 1	1.2 ± 1			
Calcium (mg)			<0.001	<0.001	0.18
Male (*n* = 71)	1373.5 ± 619	1077.6 ± 487			
Female (*n* = 230)	1002.2 ± 434	780.0 ± 330			
Zinc (mg)			<0.001	<0.001	0.006
Male (*n* = 71)	16.4 ± 7	12.2 ± 5			
Female (*n* = 230)	9.9 ± 4	7.4 ± 3			
Iron (mg)			<0.001	<0.001	0.005
Male (*n* = 71)	19.7 ± 8	14.9 ± 6			

Female (*n* = 230)	12.7 ± 5	9.8 ± 4			
Potassium (mg)			<0.001	<0.001	0.036
Male (*n* = 71)	3610.9 ± 1504	2730.4 ± 1151			
Female (*n* = 230)	2573.7 ± 1004	1966.4 ± 731			
Sodium (mg)			<0.001	<0.001	0.30
Male (*n* = 71)	4274.6 ± 1728	3634.2 ± 1459			
Female (*n* = 230)	2929.2 ± 1120	2460.9 ± 1007			
Magnesium (mg)			<0.001	<0.001	0.002
Male (*n* = 71)	442.1 ± 198	319.6 ± 122			
Female (*n* = 230)	293.7 ± 116	220.8 ± 83			
Vitamin B12 (mcg)			<0.001	<0.001	0.001
Male (*n* = 71)	7.7 ± 4	5.5 ± 2			
Female (*n* = 230)	4.3 ± 2	3.2 ± 1			
Phosphorus (mg)			<0.001	<0.001	0.11
Male (*n* = 71)	1926.7 ± 812	1535.9 ± 659			
Female (*n* = 230)	1290.5 ± 507	1011.4 ± 379			
Copper (mg)			<0.001	<0.001	0.024
Male (*n* = 71)	1.8 ± 1	1.4 ± 1			
Female (*n* = 230)	1.2 ± 1	1.0 ± 0			
Selenium (mcg)			<0.001	<0.001	0.50
Male (*n* = 71)	150.1 ± 66	131.7 ± 77			
Female (*n* = 230)	94.6 ± 38	72.1 ± 27			
Caffeine (mg)			0.90	0.47	0.18
Male (*n* = 71)	48.8 ± 44	55.8 ± 59			
Female (*n* = 230)	54.0 ± 48	51.9 ± 45			
Total Folate (mcg)			<0.001	<0.001	0.001
Male (*n* = 71)	453.1 ± 190	334.7 ± 127			
Female (*n* = 230)	301.8 ± 114	237.7 ± 90			

All results are shown as mean ± SD
** Significance from 2-way repeated measures ANOVA, (Group: sex; Time: pre to post), significantly different with P value <0.05*

Table 14 displays select macronutrient and micronutrient intake for males who lived in residence (*n* = 55), those who lived at home (*n* = 10) and those who lived in a student house (*n* = 6). Despite non-significant group effects (likely due to small sample sizes), those who lived in residence and at home had an increase in alcohol intake compared to those living in a student house (who decreased their alcohol intake). There was a trend towards a significant interaction for caffeine such that caffeine intake increased only in those living in residence and decreased in the other groups. Time effects were seen for fat, monounsaturated fat, protein, carbohydrates, fibre, vitamin D, calcium such that there were decreases across the groups for each of these nutrients. These reflect the changes in the whole sample.

Table 14: Select nutrient and caffeine intakes of males stratified by living arrangement from the beginning to end of first-year university

	Pre	Post	Group p*	Time p*	Interaction p*
MALES (*n* = 71)					
Calories (kcal)			0.81	0.075	0.42
Residence (*n* = 55)	2724 ± 1127	2205 ± 862			
Home (*n* = 10)	2535 ± 956	2442 ± 1163			
Student House (*n* = 6)	2884 ± 1411	2573 ± 1391			
Fat (g)			0.84	0.042	0.77
Residence (*n* = 55)	104.9 ± 42	87.9 ± 36			
Home (*n* = 10)	103.2 ± 42	95.7 ± 49			
Student House (*n* = 6)	99.3 ± 13	79.3 ± 14			
Saturated Fat (g)			0.98	0.086	0.74
Residence (*n* = 55)	34.7 ± 14	28.6 ± 12			
Home (*n* = 10)	34.7 ± 17	29.4 ± 15			
Student House (*n* = 6)	31.4 ± 6	29.9 ± 18			
Monounsaturated Fat			0.87	0.025	0.97

(g)					
Residence (*n* = 55)	38.9 ± 16	33.4 ± 14			
Home (*n* = 10)	37.6 ± 14	31.2 ± 13			
Student House (*n* = 6)	37.7 ± 6	30.8 ± 6			
Polyunsaturated Fat			0.86	0.065	0.52
(g)					
Residence (*n* = 55)	23.2 ± 11	18.6 ± 8			
Home (*n* = 10)	22.5 ± 8	21.6 ± 11			
Student House (*n* = 6)	21.6 ± 5	17.9 ± 5			
Protein (g)			0.63	0.019	0.42
Residence (*n* = 55)	111.9 ± 50	88.9 ± 39			
Home (*n* = 10)	100.3 ± 43	95.6 ± 50			
Student House (*n* = 6)	96.8 ± 22	72 ± 20			
Carbohydrates (g)			0.61	0.001	0.33
Residence (*n* = 55)	317.9 ± 135	233.2 ± 83			
Home (*n* = 10)	303.1 ± 111	273.3 ± 128			
Student House (*n* = 6)	283.1 ± 97	194.9 ± 36			
Cholesterol (mg)			0.80	0.069	0.50
Residence (*n* = 55)	358.2 ± 156	331.1 ± 158			
Home (*n* = 10)	377.4 ± 153	347.3 ± 209			
Student House (*n* = 6)	376.6 ± 78	258.8 ± 89			
Fibre (g)			0.76	0.003	0.80
Residence (*n* = 55)	23.9 ± 11	17.4 ± 7			
Home (*n* = 10)	21.0 ± 8	16.5 ± 7			
Student House (*n* = 6)	23.7 ± 10	18.7 ± 13			
Alcohol (ethanol) (mg)			0.27	0.81	0.80
Residence (*n* = 55)	8.3 ± 14	10.8 ± 11			
Home (*n* = 10)	4.7 ± 7	5.2 ± 7			
Student House (*n* = 6)	7.1 ± 7	6.0 ± 3			
Total Sugars (g)			0.60	0.09	0.05
Residence (*n* = 55)	146.3 ± 71	103.0 ± 42			
Home (*n* = 10)	136.1 ± 50	138.3 ± 70			
Student House (*n* = 6)	116.6 ± 64	104.8 ± 64			
Vitamin D (mcg)			0.48	0.002	0.30

Residence (*n* = 55)	6.9 ± 3	5.0 ± 3			
Home (*n* = 10)	6.7 ± 3	6.2 ± 4			
Student House (*n* = 6)	5.8 ± 4	3.6 ± 2			
Calcium (mg)			0.59	0.045	0.12
Residence (*n* = 55)	1406.3 ± 630	1047.2 ± 436			
Home (*n* = 10)	1391.1 ± 673	1264.0 ± 693			
Student House (*n* = 6)	1067.5 ± 379	1045.1 ± 568			
Caffeine (mg)			0.91	0.37	0.065
Residence (*n* = 55)	45.4 ± 41	60.2 ± 64			
Home (*n* = 10)	57.0 ± 53	36.8 ± 34			
Student House (*n* = 6)	65.9 ± 63	46.5 ± 37			

All results are shown as mean ± SD
** Significance from 2-way repeated measures ANOVA, (Group: living arrangement; Time: pre to post), significantly different with P value <0.05*

Table 15 displays select macronutrient and micronutrient intake for females who lived in residence (*n* = 163), those who lived at home (*n* = 55) and those who lived in a student house (*n* = 11). There were significant interaction effects for calories, protein, carbohydrates, fibre, alcohol and total sugars. When looking at pairwise comparisons no significant differences existed between any living arrangement for calories, protein, carbohydrates, fibre and total sugars. When looking at group differences for alcohol those in residence increased their alcohol intake more than those who live at home or in a student house. Group effects were also seen for monounsaturated fat and alcohol. Time effects also existed for calories, fat, saturated fat, polyunsaturated fat, protein, carbohydrates and fibre such that these nutrients decreased from the beginning to the end of first-year.

Table 15: Select nutrient and caffeine intakes of females stratified by living arrangement from the beginning to end of first-year university

	Pre	Post	Group p*	Time p*	Interaction p*
FEMALES (*n* = 230)					
Calories (kcal)			0.45	0.01	0.008
Residence (*n* = 163)	1914 ± 747	1478 ± 524			
Home (*n* = 55)	1658 ± 585	1512 ± 523			
Student House (*n* = 11)	1843 ± 692	1233 ± 387			
Fat (g)			0.18	0.048	0.077
Residence (*n* = 163)	75.6 ± 32	59.3 ± 24			
Home (*n* = 55)	65.6 ± 28	60.3 ± 25			
Student House (*n* = 11)	65.9 ± 26	48.3 ± 18			
Saturated Fat (g)			0.57	0.012	0.051
Residence (*n* = 163)	24.6 ± 10	19.6 ± 8			
Home (*n* = 55)	21.8 ± 10	20.5 ± 9			
Student House (*n* = 11)	23.5 ± 9	17.9 ± 6			
Monounsaturated Fat (g)			0.039	0.30	0.077
Residence (*n* = 163)	27.1 ± 12	22.0 ± 10			
Home (*n* = 55)	23.3 ± 9	21.8 ± 9			
Student House (*n* = 11)	22.9 ± 10	16.3 ± 6			
Polyunsaturated Fat (g)			0.18	0.033	0.35
Residence (*n* = 163)	16.3 ± 7	13.4 ± 6			
Home (*n* = 55)	14.1 ± 6	12.7 ± 6			
Student House (*n* = 11)	14.0 ± 7	10.2 ± 6			
Protein (g)			0.33	0.001	0.015
Residence (*n* = 163)	71.5 ± 29	51.8 ± 18			
Home (*n* = 55)	61.9 ± 22	54.1 ± 21			
Student House (*n* = 11)	65.8 ± 27	45.3 ± 13			
Carbohydrates (g)			0.99	0.018	0.006
Residence (*n* = 163)	228.2 ± 86	176.4 ± 69			
Home (*n* = 55)	210.4 ± 80	190.5 ± 66			
Student House (*n* = 11)	245.9 ± 93	150.9 ± 58			

Cholesterol (mg)			0.21	0.21	0.15
Residence (*n* = 163)	215.9 ± 92	197.6 ± 95			
Home (*n* = 55)	214.7 ± 119	185.9 ± 91			
Student House (*n* = 11)	175.5 ± 76	154.6 ± 56			
Fibre (g)			0.45	0.002	0.008
Residence (*n* = 163)	17.5 ± 7	12.7 ± 5			
Home (*n* = 55)	17.2 ± 7	15.3 ± 6			
Student House (*n* = 11)	17.1 ± 8	10.8 ± 7			
Alcohol (ethanol) (mg)			<0.001	0.32	0.049
Residence (*n* = 163)	3.5 ± 4	7.0 ± 7			
Home (*n* = 55)	1.6 ± 2	3.0 ± 4			
Student House (*n* = 11)	1.9 ± 2	3.1 ± 3			
Total Sugars (g)			0.10	0.13	0.034
Residence (*n* = 163)	104.4 ± 45	80.8 ± 37			
Home (*n* = 55)	96.3 ± 44	87.7 ± 36			
Student House (*n* = 11)	109.3 ± 41	72.8 ± 24			
Vitamin D (mcg)			0.38	0.092	0.23
Residence (*n* = 163)	4.3 ± 2	3.1 ± 2			
Home (*n* = 55)	4.1 ± 2	3.5 ± 2			
Student House (*n* = 11)	5.0 ± 2	3.5 ± 2			
Calcium (mg)			0.65	0.01	0.33
Residence (*n* = 163)	1008.2 ± 418	761.4 ± 321			
Home (*n* = 55)	953.4 ± 481	814.3 ± 367			
Student House (*n* = 11)	1137.6 ± 442	884.7 ± 276			
Caffeine (mg)			0.53	0.84	0.10
Residence (*n* = 163)	51.4 ± 47	49.5 ± 43			
Home (*n* = 55)	60.3 ± 55	58.2 ± 46			
Student House (*n* = 11)	60.8 ± 37	56.3 ± 63			

All results are shown as mean ± SD

** Significance from 2-way repeated measures ANOVA, (Group: living arrangement; Time: pre to post), significantly different with P value <0.05*

Table 16 displays the select nutrient intake for males stratified by Faculty. There were no interactions or group effects seen for males for any of the nutrients. Time effects were seen for calories, fat, saturated fat, monounsaturated fat, polyunsaturated fat, protein, carbohydrates, fibre, total sugars, vitamin D and calcium such that there were decreases in each of these nutrients. These changes reflected what was seen in the entire sample.

Table 16: Select nutrient and caffeine intakes of males stratified by Faculty from the beginning to end of first-year university

	Pre	Post	Group p*	Time p*	Interaction p*
MALES (*n* = 71)					
Calories (kcal)			0.48	0.002	0.94
AHS (*n* = 36)	2882 ± 1116	2417 ± 1052			
Arts (*n* = 10)	2475 ± 931	2206 ± 813			
Business (*n* = 14)	2448 ± 1346	2002 ± 844			
Math and Science (*n* = 11)	2700 ± 987	2186 ± 853			
Fat (g)			0.42	0.016	0.63
AHS (*n* = 36)	112.2 ± 41	91.5 ± 40			
Arts (*n* = 10)	98.3 ± 43	93.6 ± 35			
Business (*n* = 14)	89.4 ± 38	80.3 ± 35			
Math and Science (*n* = 11)	102.0 ± 34	83.3 ± 29			
Saturated Fat (g)			0.64	0.007	0.88
AHS (*n* = 36)	36.4 ± 14	30.3 ± 14			
Arts (*n* = 10)	31.6 ± 14	28.9 ± 12			
Business (*n* = 14)	31.8 ± 15	26.6 ± 12			
Math and Science (*n* = 11)	34.0 ± 12	26.7 ± 9			
Monounsaturated Fat (g)			0.39	0.045	0.24
AHS (*n* = 36)	41.9 ± 15	33.1 ± 14			
Arts (*n* = 10)	37.5 ± 16	37.7 ± 16			
Business (*n* = 14)	32.2 ± 14	30.7 ± 15			
Math and Science (*n* = 11)	36.9 ± 13	30.7 ± 10			

Polyunsaturated Fat (g)			0.37	0.008	0.74
AHS (*n* = 36)	25.0 ± 10	19.9 ± 9			
Arts (*n* = 10)	20.9 ± 10	19.5 ± 7			
Business (*n* = 14)	19.9 ± 12	16.2 ± 7			
Math and Science (*n* = 11)	22.4 ± 8	18.7 ± 9			
Protein (g)			0.64	0.001	0.93
AHS (*n* = 36)	115.9 ± 49	93.1 ± 43			
Arts (*n* = 10)	100.0 ± 43	83.2 ± 31			
Business (*n* = 14)	102.9 ± 47	80.2 ± 34			
Math and Science (*n* = 11)	102.5 ± 47	88.2 ± 43			
Carbohydrates (g)			0.60	<0.001	0.53
AHS (*n* = 36)	324.2 ± 115	236.0 ± 88			
Arts (*n* = 10)	283.6 ± 104	230.3 ± 83			
Business (*n* = 14)	276.6 ± 153	227.5 ± 97			
Math and Science (*n* = 11)	348.7 ± 157	249.4 ± 96			
Cholesterol (mg)			0.57	0.086	0.90
AHS (*n* = 36)	373.1 ± 136	348.8 ± 180			
Arts (*n* = 10)	359.0 ± 188	312.2 ± 115			
Business (*n* = 14)	319.0 ± 126	290.3 ± 143			
Math and Science (*n* = 11)	386.3 ± 189	317.6 ± 160			
Fibre (g)			0.50	<0.001	0.93
AHS (*n* = 36)	24.1 ± 10	17.3 ± 9			
Arts (*n* = 10)	23.6 ± 8	17.5 ± 5			
Business (*n* = 14)	20.6 ± 10	15.3 ± 6			
Math and Science (*n* = 11)	25.1 ± 13	20.2 ± 8			
Alcohol (ethanol) (mg)			0.14	0.36	0.89
AHS (*n* = 36)	8.8 ± 17	10.7 ± 10			
Arts (*n* = 10)	10.9 ± 11	13.7 ± 14			
Business (*n* = 14)	4.5 ± 5	8.4 ± 9			
Math and Science (*n* = 11)	5.0 ± 6	4.2 ± 4			
Total Sugars (g)			0.29	<0.001	0.60
AHS (*n* = 36)	151.4 ± 64	112.7 ± 54			
Arts (*n* = 10)	113.8 ± 56	97.0 ± 39			

Business (*n* = 14)	124.6 ± 65	99.3 ± 41			
Math and Science (*n* = 11)	161.7 ± 86	114.2 ± 54			
Vitamin D (mcg)			0.64	<0.001	0.50
AHS (*n* = 36)	7.2 ± 3	5.4 ± 3			
Arts (*n* = 10)	5.9 ± 4	5.3 ± 4			
Business (*n* = 14)	6.5 ± 3	4.2 ± 2			
Math and Science (*n* = 11)	6.4 ± 4	4.5 ± 3			
Calcium (mg)			0.74	<0.001	0.72
AHS (*n* = 36)	1457.5 ± 621	1111.3 ± 525			
Arts (*n* = 10)	1214.9 ± 502	1036.2 ± 458			
Business (*n* = 14)	1302.6 ± 639	979.6 ± 378			
Math and Science (*n* = 11)	1346.2 ± 721	1129.4 ± 544			
Caffeine (mg)			0.10	0.28	0.90
AHS (*n* = 36)	58.0 ± 52	64.3 ± 59			
Arts (*n* = 10)	49.7 ± 31	68.1 ± 77			
Business (*n* = 14)	24.5 ± 22	29.4 ± 28			
Math and Science (*n* = 11)	48.9 ± 42	50.4 ± 64			

All results are shown as mean ± SD
** Significance from 2-way repeated measures ANOVA, (Group: Faculty; Time: pre to post), significantly different with P value <0.05*

Table 17 displays select nutrients stratified by Faculty for females. Group effects were seen for carbohydrates, fibre and total sugars. All nutrients except for caffeine and cholesterol showed main effects for time. No interactions effects were seen for any of the nutrients. When looking at alcohol more specifically the time effect displayed an increase, while all other time effects displayed decreases.

Table 17: Select nutrient and caffeine intakes of females stratified by Faculty from the beginning to end of first-year university

	Pre	Post	Group p*	Time p*	Interaction p*
FEMALES (*n* = 230)					
Calories (kcal)			0.054	<0.001	0.75
AHS (*n* = 100)	1897 ± 686	1482 ± 543			
Arts (*n* = 90)	1742 ± 723	1376 ± 470			
Business (*n* = 15)	1906 ± 785	1619 ± 596			
Math and Science (*n* = 25)	2022 ± 724	1722 ± 459			
Fat (g)			0.27	<0.001	0.45
AHS (*n* = 100)	73.1 ± 30	57.0 ± 23			
Arts (*n* = 90)	71.0 ± 33	57.3 ± 23			
Business (*n* = 15)	74.8 ± 30	65.8 ± 28			
Math and Science (*n* = 25)	77.6 ± 27	70.5 ± 27			
Saturated Fat (g)			0.27	<0.001	0.65
AHS (*n* = 100)	24.0 ± 10	19.2 ± 8			
Arts (*n* = 90)	23.3 ± 11	19.1 ± 8			
Business (*n* = 15)	23.8 ± 11	21.8 ± 10			
Math and Science (*n* = 25)	26.3 ± 9	23.2 ± 10			
Monounsaturated Fat (g)			0.13	<0.001	0.79
AHS (*n* = 100)	25.6 ± 10	21.2 ± 10			
Arts (*n* = 90)	25.5 ± 13	20.8 ± 9			
Business (*n* = 15)	28.1 ± 10	24.3 ± 10			
Math and Science (*n* = 25)	28.8 ± 12	26.2 ± 11			
Polyunsaturated Fat (g)			0.24	<0.001	0.53
AHS (*n* = 100)	16.1 ± 7	13.0 ± 7			
Arts (*n* = 90)	14.8 ± 7	12.4 ± 6			
Business (*n* = 15)	16.8 ± 7	14.2 ± 6			
Math and Science (*n* = 25)	16.5 ± 6	15.3 ± 6			
Protein (g)			0.22	<0.001	0.96
AHS (*n* = 100)	69.9 ± 26	52.3 ± 19			
Arts (*n* = 90)	65.8 ± 29	49.9 ± 18			
Business (*n* = 15)	72.9 ± 31	54.6 ± 22			
Math and Science (*n* = 25)	75.5 ± 27	57.8 ± 17			

Carbohydrates (g)			0.001	<0.001	0.39
AHS (*n* = 100)	235.9 ± 83	182.4 ± 69			
Arts (*n* = 90)	202.6 ± 76	160.3 ± 59			
Business (*n* = 15)	244.5 ± 112	191.7 ± 76			
Math and Science (*n* = 25)	247.8 ± 87	221.5 ± 66			
Cholesterol (mg)			0.056	0.18	0.49
AHS (*n* = 100)	211.6 ± 104	188.8 ± 93			
Arts (*n* = 90)	205.0 ± 95	182.1 ± 87			
Business (*n* = 15)	231.4 ± 78	250.2 ± 114			
Math and Science (*n* = 25)	242.5 ± 95	220.7 ± 96			
Fibre (g)			0.005	<0.001	0.46
AHS (*n* = 100)	18.1 ± 6	13.4 ± 5			
Arts (*n* = 90)	15.8± 7	12.3 ± 6			
Business (*n* = 15)	18.4 ± 7	13.6 ± 6			
Math and Science (*n* = 25)	20.3 ± 8	16.2 ± 6			
Alcohol (ethanol) (mg)			0.31	<0.001	0.84
AHS (*n* = 100)	3.5 ± 4	6.6 ± 7			
Arts (*n* = 90)	2.9 ± 3	5.4 ± 6			
Business (*n* = 15)	1.5 ± 2	5.2 ± 6			
Math and Science (*n* = 25)	2.4 ± 3	5.1 ± 6			
Total Sugars (g)			0.043	<0.001	0.94
AHS (*n* = 100)	105.2 ± 41	85.9 ± 37			
Arts (*n* = 90)	95.8 ± 43	75.2 ± 36			
Business (*n* = 15)	101.6 ± 59	77.9 ± 34			
Math and Science (*n* = 25)	117.7 ± 50	94.5 ± 26			
Vitamin D (mcg)			0.48	<0.001	0.93
AHS (*n* = 100)	4.4 ± 2	3.3 ± 2			
Arts (*n* = 90)	4.1 ± 2	3.0 ± 2			
Business (*n* = 15)	4.5 ± 3	3.7 ± 2			
Math and Science (*n* = 25)	4.4 ± 2	3.3 ± 1			
Calcium (mg)			0.20	<0.001	0.94
AHS (*n* = 100)	1050.4 ± 416	816.9 ± 329			
Arts (*n* = 90)	941.5 ± 431	726.1 ± 323			
Business (*n* = 15)	967.5 ± 577	799.7 ± 439			

Math and Science (*n* = 25)	1048.8 ± 424	814.9 ± 274			
Caffeine (mg)			0.56	0.36	0.69
AHS (*n* = 100)	55.2 ± 45	50.8 ± 41			
Arts (*n* = 90)	49.2 ± 48	51.8 ± 48			
Business (*n* = 15)	54.6 ± 54	46.6 ± 43			
Math and Science (*n* = 25)	66.4 ± 59	59.9 ± 50			

All results are shown as mean ± SD
** Significance from 2-way repeated measures ANOVA, (Group: Faculty; Time: pre to post), significantly different with P value <0.05*

4.3.2 Food Intake Frequency

The food frequency tables (Table 18 and 19) describe the percentage of male and female students who were eating certain foods within the categories of; everyday, 3-6 times per week, 1-2 times per week, 1-3 times per month, a few times per 6 months or never. For females, the percent of students who selected "never consume" for wine and liquor decreased pre to post with a negative percent change of 30% and 28%, respectively. This indicates that some female students began drinking wine and liquor over the course of first-year university. Furthermore, there was a 38% percent increase in female students who "never consumed" vegetables such as carrots, broccoli and spinach indicating that some female students decreased their consumption of these vegetables over the course of first-year university. For males, there was a decrease in the percentage of students who never drank beer (22%), wine (14%) and liquor (47%) indicating that some male students began drinking beer, wine and liquor over the course of first-year university. The same trend was seen for males with vegetable intake.

Table 18: Food frequency percent and percent changes in males (*n* = 71)

	Everyday (%)			3-6 Times Per Week (%)			1-2 Times Per Week (%)			1-3 Times Per Month (%)			A Few Times Per 6 Months (%)			Never (%)		
	PRE	**POST**	**% Δ**	**PRE**	**POST**	**% Δ**	**PRE**	**POST**	**% Δ**	**PRE**	**POST**	**% Δ**	**PRE**	**POST**	**% Δ**	**PRE**	**POST**	**% Δ**
EGGS	6	11	**83**	30	24	**-20**	39	25	**-36**	17	24	**41**	0	7	0	8	7	-13
YOGURT	4	0	**-100**	20	17	-15	30	20	**-33**	15	27	**80**	14	14	0	17	23	**35**
CHEESE	8	7	-13	42	34	-19	30	31	3	8	20	**150**	8	3	**-63**	3	6	**100**
COLD CEREALS	10	8	**-20**	34	13	**-62**	28	18	**-36**	17	18	6	4	20	**400**	7	23	**229**
OATMEAL	7	3	**-57**	10	15	**50**	23	20	-13	18	11	**-39**	11	13	18	31	37	19
RICE	2	1	**-50**	8	12	**50**	37	29	**-22**	30	31	3	4	9	**125**	19	18	-5
PANCAKES/PASTRIES[a]	1	1	0	1	4	**300**	22	13	**-41**	37	39	5	23	17	**-26**	16	27	**69**
BREADS	5	5	0	31	17	**-45**	35	37	6	17	25	**47**	4	6	**50**	8	10	**25**
STARCH VEGETABLES	0	0	0	21	11	**-48**	31	25	-19	21	25	19	14	22	**57**	14	17	**21**
CORN	0	0	0	2	4	**100**	31	12	**-61**	40	38	-5	21	29	**38**	6	17	**183**
SWEET POTATOES	0	0	0	14	5	**-64**	27	27	0	20	24	**20**	15	19	**27**	25	24	-4
POTATOES	0	0	0	48	24	**-50**	37	35	-5	6	15	**150**	6	18	**200**	3	8	**167**
VEGETABLES (ALL)	2	2	0	18	13	**-28**	35	28	**-20**	24	25	4	6	11	**83**	15	21	**40**
CARROTS	0	0	0	24	13	**-46**	48	39	**-19**	20	32	**60**	3	7	**133**	6	8	**33**
BROCCOLI	1	1	0	21	11	**-48**	43	34	**-21**	18	28	**56**	8	10	**25**	10	16	**60**
GREEN BEANS	0	0	0	10	6	**-40**	40	34	-15	32	28	-13	8	20	**150**	10	13	**30**
COOKED GREENS	3	1	**-67**	8	7	-13	32	13	**-59**	23	22	-4	7	17	**143**	27	39	**44**
GREEN SALAD	7	6	-14	37	23	**-38**	21	25	19	28	27	-4	3	6	**100**	4	13	**225**
RAW TOMATOES	1	1	0	15	15	0	18	23	**28**	18	17	-6	8	7	-13	38	37	-3
OTHER VEGETABLES[b]	1	2	**100**	9	17	**89**	38	27	**-29**	32	23	**-28**	7	10	**43**	13	20	**54**

TROPICAL FRUIT	4	3	**-25**	14	13	-7	29	18	**-38**	29	27	-7	10	16	**60**	14	24	**71**
WATERMELONS	0	0	0	7	4	**-43**	23	23	0	54	25	**-54**	11	23	**109**	6	25	**317**
BANANAS	13	10	**-23**	25	21	-16	38	27	**-29**	15	27	**80**	1	10	**900**	7	6	-14
ORANGES	3	3	0	13	18	**38**	35	23	**-34**	28	27	-4	10	8	**-20**	11	21	**91**
PEACHES	1	0	**-100**	8	11	**38**	31	10	**-68**	27	20	**-26**	14	24	**71**	18	35	**94**
OTHER FRESH FRUIT[c]	6	1	**-83**	20	13	**-35**	32	15	**-53**	35	35	0	4	17	**325**	3	18	**500**
RAISINS/DATES	1	2	**100**	12	9	**-25**	20	12	**-40**	22	26	18	17	15	-12	29	36	**24**
TEMPERATE FRUIT	9	9	0	9	3	**-67**	24	24	0	44	34	**-23**	11	24	**118**	4	7	**75**
BERRIES	10	5	**-50**	10	3	**-70**	21	21	0	31	28	-10	21	33	**57**	7	10	**43**
APPLES/PEARS	9	11	**22**	9	4	**-56**	25	26	4	50	38	**-24**	5	17	**240**	2	4	**100**
AVOCADO	0	0	0	5	1	**-80**	10	12	**20**	15	16	7	20	18	-10	49	53	8
BEANS	0	0	0	7	5	**-29**	16	18	13	38	29	**-24**	15	13	-13	24	35	**46**
MEAT SUBSTITUTES	1	1	0	0	0	0	0	0	0	10	3	**-70**	7	10	**43**	82	86	5
PIZZA	0	0	0	6	6	0	40	35	-13	40	44	10	7	10	**43**	7	6	-14
MAC AND CHEESE	0	0	0	1	1	0	18	8	**-56**	39	37	-5	17	14	-18	21	39	**86**
SPAGHETTI/NOODLES	0	0	0	6	14	**133**	37	24	**-35**	33	30	-9	8	12	**50**	16	20	**25**
MEAT DISHES[d]	0	0	0	8	7	-13	23	20	-13	40	33	-18	14	18	**29**	15	22	**47**
FRIED CHICKEN	0	1	0	4	11	**175**	28	30	7	46	34	**-26**	14	15	7	7	8	14
POULTRY	0	1	0	9	9	0	24	24	0	33	24	**-27**	14	16	14	19	26	**37**
SHELLFISH	0	0	0	0	1	0	8	7	-13	25	21	-16	31	24	**-23**	34	46	**35**
TUNA/SALMON	0	0	0	3	1	**-67**	10	8	**-20**	26	19	**-27**	17	18	6	44	53	**20**
FRIED FISH	0	0	0	1	1	0	9	4	**-56**	21	13	**-38**	25	32	**28**	43	49	14
NUTS	3	4	**33**	13	9	**-31**	21	17	-19	20	18	-10	14	11	**-21**	29	39	**34**

BARS	2	3	**50**	16	10	**-38**	17	22	**29**	14	19	**36**	11	14	**27**	39	33	-15
POPCORN	0	1	0	6	3	**-50**	15	17	13	32	28	-13	30	27	-10	15	24	**60**
CRACKERS	0	0	0	2	1	**-50**	10	9	-10	29	22	**-24**	15	20	**33**	43	48	12
SNACKS[e]	0	0	0	3	2	**-33**	16	16	0	48	40	-17	14	22	**57**	20	20	0
FRENCH FRIES	0	0	0	3	3	0	17	14	-18	44	41	-7	7	11	**57**	29	32	10
DONUTS/CAKES	0	0	0	1	3	**200**	18	13	**-28**	39	38	-3	27	29	7	14	16	14
ICE CREAM	0	0	0	7	3	**-57**	24	6	**-75**	42	44	5	15	31	**107**	10	17	**70**
CANDY	2	1	**-50**	5	3	**-40**	23	22	-4	39	45	15	18	15	-17	13	14	8
MARGARINE	7	4	**-43**	14	10	**-29**	24	17	**-29**	4	20	**400**	13	13	0	38	37	-3
BUTTER	0	0	0	14	7	**-50**	34	23	**-32**	20	30	**50**	13	13	0	20	28	**40**
MAYO	0	1	0	11	10	-9	38	34	-11	18	23	**28**	7	3	**-57**	25	30	**20**
KETCHUP	6	4	**-33**	24	25	4	38	39	3	20	10	**-50**	6	11	**83**	6	10	**67**
BARBECUE SAUCE	0	3	0	20	14	**-30**	42	32	**-24**	18	24	**33**	4	7	**75**	15	20	**33**
GRAVY	0	0	0	1	4	**300**	23	21	-9	39	25	**-36**	10	18	**80**	27	31	15
JAM	0	0	0	7	6	-14	20	13	**-35**	27	23	-15	8	17	**113**	38	42	11
SALT	3	4	**33**	14	11	**-21**	23	15	**-35**	15	14	-7	7	11	**57**	38	44	16
CHOCOLATE MILK	3	6	**100**	18	15	-17	25	24	-4	27	30	11	11	6	**-45**	15	20	**33**
MILK	15	6	**-60**	21	18	-14	23	20	-13	13	17	**31**	6	11	**83**	23	28	**22**
MEAL REPLACEMENT	6	11	**83**	27	18	**-33**	8	10	**25**	8	7	-13	4	7	**75**	46	46	0
JUICE	2	1	**-50**	11	15	**36**	25	24	-4	29	22	**-24**	11	11	0	22	26	18
ENERGY DRINKS	0	0	0	0	0	0	6	3	**-50**	4	11	**175**	13	17	**31**	77	69	-10
SOFT DRINKS	4	0	**-100**	4	11	**175**	25	27	8	28	27	-4	17	11	**-35**	21	24	14
BEER	0	0	0	6	6	0	24	31	**29**	35	34	-3	18	14	**-22**	18	14	**-22**

WINE	0	0	0	0	0	0	6	7	17	15	17	13	23	28	**22**	56	48	-14
LIQUOR	0	0	0	3	6	**100**	14	27	**93**	34	32	-6	17	18	6	32	17	**-47**
COFFEE	11	11	0	8	18	**125**	18	8	**-56**	11	10	-9	4	7	**75**	46	45	-2
HOT TEA	1	1	0	10	7	**-30**	6	25	**317**	20	10	**-50**	14	7	**-50**	49	49	0

[a] *Breakfast pastries such as muffins, scones, sweet rolls, Danishes, pop tarts.*
[b] *Squash, cauliflower, peppers, okra, nopales*
[c] *Grapes, plums, mangos, fruit salad*
[d] *Burgers, hot dogs, sausage/bacon, ribs, tacos, pork, lunch meat, beef, mixed meat dishes*
[e] *Pretzels, chips, tortilla chips*

Table 19: Food frequency percent and percent changes in females (*n* = 230)

	Everyday (%)			**3-6 Times Per Week (%)**			**1-2 Times Per Week (%)**			**1-3 Times Per Month (%)**			**A Few Times Per 6 Months (%)**			**Never (%)**		
	PRE	**POST**	**% Δ**	**PRE**	**POST**	**% Δ**	**PRE**	**POST**	**% Δ**	**PRE**	**POST**	**% Δ**	**PRE**	**POST**	**% Δ**	**PRE**	**POST**	**% Δ**
EGGS	1	1	0	16	16	0	31	30	-3	34	29	-15	8	10	**25**	11	14	**27**
YOGURT	4	5	**25**	27	21	**-22**	29	25	-14	20	22	10	10	13	**30**	10	14	**40**
CHEESE	4	6	**50**	38	36	-5	35	37	6	15	14	-7	3	5	**67**	5	3	**-40**
COLD CEREALS	3	3	0	21	9	**-57**	32	27	-16	24	28	17	12	19	**58**	7	14	**100**
OATMEAL	1	2	**100**	9	5	**-44**	20	14	**-30**	28	25	-11	16	19	19	27	36	**33**
RICE	1	0	**-100**	7	4	**-43**	25	16	**-36**	33	37	12	15	17	13	18	25	**39**
PANCAKES/PASTRIES[a]	0	0	0	3	4	**33**	21	18	-14	51	43	-16	18	24	**33**	7	12	**71**
BREADS	4	3	**-25**	31	20	**-35**	39	36	-8	19	27	**42**	3	9	**200**	3	6	**100**
STARCH VEGETABLES	0	0	0	19	11	**-42**	28	24	-14	29	31	7	13	18	**38**	11	17	**55**
CORN	0	0	0	11	5	**-55**	32	21	**-34**	38	38	0	16	21	**31**	2	15	**650**
SWEET POTATOES	0	0	0	5	6	**20**	18	15	-17	37	33	-11	17	18	6	23	27	17

POTATOES	1	0	**-100**	43	22	**-49**	38	37	-3	11	20	**82**	4	13	**225**	3	7	**133**
VEGETABLES (ALL)	1	1	0	21	13	**-38**	33	29	-12	24	27	13	7	12	**71**	13	18	**38**
CARROTS	1	1	0	43	24	**-44**	38	40	5	11	22	**100**	4	9	**125**	3	4	**33**
BROCCOLI	0	0	0	15	10	**-33**	38	33	-13	31	32	3	9	12	**33**	6	12	**100**
GREEN BEANS	0	0	0	11	6	**-45**	36	26	**-28**	33	31	-6	10	19	**90**	10	17	**70**
COOKED GREENS	0	0	0	11	6	**-45**	36	26	**-28**	33	31	-6	10	19	**90**	10	17	**70**
GREEN SALAD	1	1	0	36	21	**-42**	36	37	3	22	27	**23**	2	8	**300**	3	6	**100**
RAW TOMATOES	0	1	0	19	10	**-47**	30	25	-17	18	23	**28**	1	7	**600**	33	34	3
OTHER VEGETABLES[b]	3	1	**-67**	14	12	-14	39	25	**-36**	26	31	19	7	14	**100**	11	17	**55**
TROPICAL FRUIT	2	2	0	15	9	**-40**	29	20	**-31**	28	29	4	11	16	**45**	15	23	**53**
WATERMELONS	1	0	**-100**	13	7	**-46**	33	20	**-39**	37	35	-5	11	20	**82**	6	16	**167**
BANANAS	6	7	17	31	18	**-42**	29	33	14	21	24	14	7	9	**29**	6	9	**50**
ORANGES	0	2	0	8	11	**38**	35	23	**-34**	35	34	-3	9	16	**78**	13	15	15
PEACHES	1	1	0	13	3	**-77**	26	11	**-58**	29	27	-7	13	22	**69**	17	36	**112**
OTHER FRESH FRUIT[c]	4	2	**-50**	24	12	**-50**	42	27	**-36**	24	34	**42**	2	13	**550**	4	12	**200**
RAISINS/DATES	2	2	0	3	3	0	7	8	14	24	18	**-25**	21	19	-10	42	50	19
TEMPERATE FRUIT	8	3	**-63**	7	2	**-71**	24	21	-13	48	43	-10	6	17	**183**	8	15	**88**
BERRIES	5	1	**-80**	8	2	**-75**	25	21	-16	50	43	-14	6	18	**200**	8	15	**88**
APPLES/PEARS	10	5	**-50**	7	2	**-71**	23	21	-9	46	43	-7	6	15	**150**	8	14	**75**
AVOCADO	0	1	0	10	3	**-70**	20	11	**-45**	23	26	13	12	14	17	35	44	**26**
BEANS	0	0	0	4	2	**-50**	15	13	-13	28	23	-18	18	17	-6	35	45	**29**
MEAT SUBSTITUTES	0	0	0	1	0	**-100**	3	3	0	6	7	17	13	11	-15	77	78	1
PIZZA	0	0	0	3	2	**-33**	25	22	-12	59	57	-3	10	12	**20**	2	7	**250**

MAC AND CHEESE	0	0	0	2	1	**-50**	14	11	**-21**	49	47	-4	21	22	5	14	19	**36**
SPAGHETTI/NOODLES	0	0	0	6	4	**-33**	32	30	-6	43	38	-12	8	14	**75**	10	14	**40**
MEAT DISHES[d]	0	0	0	4	3	**-25**	17	12	**-29**	41	30	**-27**	20	25	**25**	18	30	**67**
FRIED CHICKEN	0	0	0	5	8	**60**	22	21	-5	52	48	-8	13	14	8	8	9	13
POULTRY	0	0	0	6	3	**-50**	23	16	**-30**	37	36	-3	18	20	11	15	26	**73**
SHELLFISH	0	0	0	1	0	**-100**	4	3	**-25**	31	21	**-32**	24	27	13	39	48	**23**
TUNA/SALMON	0	0	0	1	0	**-100**	7	3	**-57**	25	17	**-32**	19	19	0	49	60	**22**
FRIED FISH	0	0	0	13	8	**-38**	21	18	-14	16	20	**25**	22	17	**-23**	28	38	**36**
NUTS	3	1	**-67**	10	5	**-50**	19	14	**-26**	22	23	5	16	17	6	31	38	**23**
BARS	2	2	0	11	9	**-18**	23	12	**-48**	23	27	17	12	12	0	30	38	**27**
POPCORN	0	0	0	4	1	**-75**	20	17	-15	50	38	**-24**	20	34	**70**	6	10	**67**
CRACKERS	0	0	0	4	2	**-50**	19	10	**-47**	37	34	-8	16	21	**31**	23	33	**43**
SNACKS[e]	0	0	0	6	3	**-50**	23	12	**-48**	48	48	0	14	21	**50**	9	16	**78**
FRENCH FRIES	0	1	0	3	2	**-33**	17	11	**-35**	42	45	7	16	16	0	22	25	14
DONUTS/CAKES	0	1	0	3	2	**-33**	18	13	**-28**	48	43	-10	24	29	**21**	8	12	**50**
ICE CREAM	1	0	**-100**	9	2	**-78**	28	13	**-54**	48	46	-4	11	29	**164**	3	10	**233**
CANDY	2	1	**-50**	8	5	**-38**	28	21	**-25**	44	44	0	13	20	**54**	5	8	**60**
MARGARINE	5	4	**-20**	19	11	**-42**	21	20	-5	19	19	0	6	14	**133**	30	31	3
BUTTER	2	1	**-50**	16	7	**-56**	24	20	-17	23	25	9	9	17	**89**	25	30	**20**
MAYO	1	1	0	17	11	**-35**	25	24	-4	27	26	-4	9	13	**44**	21	25	19
KETCHUP	2	1	**-50**	20	17	**-15**	36	40	11	28	25	-11	5	7	**40**	8	10	**25**
BARBECUE SAUCE	1	0	**-100**	12	5	**-58**	26	17	**-35**	31	30	-3	12	15	**25**	18	32	**78**
GRAVY	0	0	0	1	5	**400**	19	17	-11	44	36	-18	21	24	14	14	18	**29**

JAM	2	0	**-100**	5	2	**-60**	16	15	-6	34	24	**-29**	14	21	**50**	29	39	**34**
SALT	7	7	0	14	9	**-36**	18	19	6	16	15	-6	15	11	**-27**	30	38	**27**
CHOCOLATE MILK	2	3	**50**	12	13	8	28	28	0	35	33	-6	14	15	7	9	8	-11
MILK	11	6	**-45**	21	12	**-43**	26	21	-19	15	21	**40**	9	13	**44**	18	28	**56**
MEAL REPLACEMENT	1	1	0	2	2	0	3	3	0	6	4	**-33**	10	11	10	78	78	0
JUICE	2	2	0	13	13	0	27	25	-7	27	25	-7	12	14	17	18	21	17
ENERGY DRINKS	0	0	0	0	0	0	0	2	0	4	7	**75**	13	13	0	83	78	-6
SOFT DRINKS	2	2	0	9	6	**-33**	20	14	**-30**	37	35	-5	17	25	**47**	16	18	13
BEER	0	0	0	0	0	0	8	9	13	19	20	5	16	13	-19	57	57	0
WINE	0	0	0	0	0	0	6	12	**100**	24	30	**25**	17	21	**24**	53	37	**-30**
LIQUOR	0	0	0	1	2	**100**	12	23	**92**	38	37	-3	17	15	-12	32	23	**-28**
COFFEE	6	5	-17	12	10	-17	11	11	0	9	16	**78**	9	11	**22**	53	46	-13
HOT TEA	8	9	13	20	18	-10	22	20	-9	16	21	**31**	10	8	**-20**	24	24	0

[a] *Breakfast pastries such as muffins, scones, sweet rolls, Danishes, pop tarts.*
[b] *Squash, cauliflower, peppers, okra, nopales*
[c] *Grapes, plums, mangos, fruit salad*
[d] *Burgers, hot dogs, sausage/bacon, ribs, tacos, pork, lunch meat, beef, mixed meat dishes*
[e] *Pretzels, chips, tortilla chips*

4.3.3 Staples of a Healthy and Unhealthy Diet

Table 20 shows the values for various foods that are part of a healthy diet (g/day) for males and females from the beginning to the end of first-year university. Overall, there were significant time effects reflecting decreases in some healthy foods eaten: yogurt, cheese, fibre cereal, oatmeal, vegetables (all), green salad, fruit (tropical, melons, bananas, peaches, other fresh fruit, temperate, berries, apples), beans, steak, tuna/salmon, nuts and milk. There were also significant interactions effects in which males decreased more than females for foods such as: yogurt, fibre cereal, carrots, green salad, oranges, beans, tuna/salmon and nuts. Males also had significant interaction effects which related to increases in foods compared to females such as other vegetables and poultry. Females increased their consumption of carrots and oranges while decreasing consumption of other vegetables, melons, temperate fruits, steak and poultry shown by significant interaction effects. Consumption of foods that are sources of protein such as yogurt, cheese, beans, steak, fish, nuts and milk decreased pre to post with the exception of poultry which only decreased in females.

Table 20: Foods that are part of a healthy diet (g/day) for males and females from the beginning to end of first-year university

	Pre	Post	Group p*	Time p*	Interaction p*
Eggs			<0.001	0.23	0.27
Male (*n* = 71)	34.5 ± 29	31.2 ± 33			
Female (*n* = 230)	13.3 ± 14	13.2 ± 15			
Yogurt			0.013	0.001	0.025

Male (*n* = 71)	28.0 ± 32	14.4 ± 19			
Female (*n* = 230)	31.2 ± 32	28.4 ± 32			
Cheese			0.54	<0.001	0.15
Male (*n* = 71)	19.0 ± 16	12.5 ± 10			
Female (*n* = 230)	16.4 ± 16	13.3 ± 12			
Fibre Cereal			0.003	<0.001	0.013
Male (*n* = 71)	8.4 ± 8	3.4 ± 5			
Female (*n* = 230)	5.5 ± 6	2.9 ± 4			
Oatmeal			<0.001	<0.001	0.42
Male (*n* = 71)	29.3 ± 43	15.9 ± 24			
Female (*n* = 230)	17.6 ± 25	7.6 ± 13			
Vegetables (all)			0.25	<0.001	0.62
Male (*n* = 71)	84.7 ± 60	64.6 ± 55			
Female (*n* = 230)	76.2 ± 50	59.7 ± 45			
Carrots			0.57	0.73	0.035
Male (*n* = 71)	14.4 ± 12	10.7 ± 15			
Female (*n* = 230)	10.3 ± 9	12.9 ± 23			
Broccoli			0.008	0.79	0.18
Male (*n* = 71)	13.3 ± 14	12.3 ± 18			
Female (*n* = 230)	7.9 ± 9	9.5 ± 15			
Green Beans			0.88	0.40	0.72
Male (*n* = 71)	6.2 ± 5	7.7 ± 14			
Female (*n* = 230)	6.4 ± 6	7.0 ± 20			
Spinach			0.58	0.26	0.58
Male (*n* = 71)	6.8 ± 9	7.7 ± 17			
Female (*n* = 230)	4.2 ± 7	6.9 ± 25			
Green Salad			0.92	<0.001	0.032
Male (*n* = 71)	32.6 ± 33	16.6 ± 19			
Female (*n* = 230)	28.5 ± 27	21.2 ± 23			
Tomatoes			0.42	0.45	0.62
Male (*n* = 71)	3.5 ± 5	3.4 ± 5			
Female (*n* = 230)	4.2 ± 6	3.7 ± 5			
Other Vegetables[a]			0.009	0.30	0.009

Male (*n* = 71)	4.4 ± 5	5.2 ± 7			
Female (*n* = 230)	6.6 ± 7	4.6 ± 6			
Tropical Fruit			0.23	<0.001	0.90
Male (*n* = 71)	85.1 ± 60	59.2 ± 52			
Female (*n* = 230)	78.2 ± 60	51.4 ± 45			
Melons					
Male (*n* = 71)	4.9 ± 4	3.0 ± 3	<0.001	<0.001	0.019
Female (*n* = 230)	9.4 ± 10	4.6 ± 7			
Bananas			0.038	<0.001	0.11
Male (*n* = 71)	27.2 ± 24	19.0 ± 19			
Female (*n* = 230)	19.8 ± 20	16.6 ± 21			
Oranges			0.035	0.051	<0.001
Male (*n* = 71)	15.8 ± 17	9.1 ± 10			
Female (*n* = 230)	8.4 ± 8	10.6 ± 16			
Peaches			0.67	<0.001	0.88
Male (*n* = 71)	12.5 ± 14	3.4 ± 4			
Female (*n* = 230)	11.8 ± 16	3.0 ± 4			
Other Fresh Fruit[b]			0.035	<0.001	0.65
Male (*n* = 71)	10.6 ± 10	4.7 ± 7			
Female (*n* = 230)	13.4 ± 14	6.6 ± 9			
Raisins, Dates			0.017	0.87	0.84
Male (*n* = 71)	0.35 ± 1	0.36 ± 1			
Female (*n* = 230)	0.77 ± 1	0.72 ± 2			
Temperate Fruits			0.17	<0.001	0.025
Male (*n* = 71)	49.0 ± 39	41.8 ± 40			
Female (*n* = 230)	48.4 ± 40	30.5 ± 31			
Berries			0.13	<0.001	0.75
Male (*n* = 71)	11.4 ± 11	5.3 ± 5			
Female (*n* = 230)	13.4 ± 14	6.8 ± 8			
Apples, Pears			0.43	<0.001	0.08
Male (*n* = 71)	28.1 ± 22	24.4 ± 22			
Female (*n* = 230)	34.3 ± 33	23.6 ± 28			
Avocado			0.069	0.17	0.18

Male (*n* = 71)	1.6 ± 3	1.6 ± 4			
Female (*n* = 230)	3.2 ± 7	2.0 ± 4			
Beans			<0.001	<0.001	<0.001
Male (*n* = 71)	23.3 ± 28	11.8 ± 14			
Female (*n* = 230)	9.5 ± 13	7.2 ± 10			
Steak			0.001	<0.001	0.006
Male (*n* = 71)	5.2 ± 5	2.5 ± 3			
Female (*n* = 230)	9.5 ± 11	3.4 ± 4			
Poultry			<0.001	0.36	0.005
Male (*n* = 71)	26.3 ± 26	32.9 ± 37			
Female (*n* = 230)	18.4 ± 18	14.9 ± 17			
Tuna/Salmon			<0.001	<0.001	<0.001
Male (*n* = 71)	14.4 ± 16	5.5 ± 6			
Female (*n* = 230)	7.6 ± 9	4.8 ± 7			
Nuts			<0.001	<0.001	0.046
Male (*n* = 71)	15.4 ± 15	8.3 ± 8			
Female (*n* = 230)	9.0 ± 9	5.0 ± 6			
Milk Substitutes			<0.001	0.93	0.85
Male (*n* = 71)	55.7 ± 70	56.0 ± 79			
Female (*n* = 230)	9.1 ± 32	8.1 ± 26			
Milk			0.008	<0.001	0.92
Male (*n* = 71)	155.6 ± 165	88.1 ± 92			
Female (*n* = 230)	122.4 ± 136	53.1 ± 67			
Tea			<0.001	0.70	0.17
Male (*n* = 71)	5.2 ± 8	15.9 ± 23			
Female (*n* = 230)	61.2 ± 91	55.2 ± 76			

All results are shown as mean ± SD
** Significance from 2-way repeated measures ANOVA (Group: sex; Time: pre to post), significantly different with P value <0.05*
[a] *Squash, cauliflower, peppers, okra, nopales*
[b] *Grapes, plums, mangos, fruit salad*

Table 21 depicts several foods that are generally seen as unhealthy along with the accompanying intakes for males and females. Significant interaction

effects occurred for sugar cereals, fried chicken, meat dishes, French fries, BBQ sauce, soft drinks and beer. Significant effects for time were observed for sugar cereals, pancakes/pastries, pizza, fried chicken, fried fish, meat dishes, crackers, snacks, French fries, donuts/cakes, ice cream, margarine, butter, mayo, energy drinks and liquor. These foods all displayed decreases besides fried chicken and soft drinks which increased in males, French fries which increased in females and energy drinks and liquor which increased in both. Intake of alcoholic beverages changed pre to post such that beer and wine showed main effects of group where females consumed more wine and males consumed more beer. Liquor showed a main effect for time where both males and females increased their intakes.

Table 21: Foods that are part of an unhealthy diet (g/day) for males and females from beginning to end of first-year university

	Pre	Post	Group p*	Time p*	Interaction p*
Sugar Cereals			<0.001	<0.001	<0.001
Male (*n* = 71)	2.5 ± 4	0.1 ± 0			
Female (*n* = 230)	1.2 ± 3	0.4 ± 1			
Pancakes/Pastries[a]			0.77	<0.001	0.11
Male (*n* = 71)	17.3 ± 14	11.7 ± 10			
Female (*n* = 230)	15.5 ± 11	12.8 ± 11			
Pizza			<0.001	0.011	0.85
Male (*n* = 71)	29.6 ± 27	25.9 ± 22			
Female (*n* = 230)	16.3 ± 13	13.1 ± 14			
Fried Chicken			0.006	0.002	0.002
Male (*n* = 71)	10.6 ± 9	15.9 ± 13			
Female (*n* = 230)	9.8 ± 10	9.9 ± 11			
Fried Fish			0.47	0.001	0.87
Male (*n* = 71)	2.5 ± 3	1.8 ± 3			

Female (*n* = 230)	2.2 ± 3	1.5 ± 2			
Meat Dishes[b]			<0.001	<0.001	0.023
Male (*n* = 71)	40.1 ± 27	29.8 ± 26			
Female (*n* = 230)	59.7 ± 44	36.8 ± 27			
Crackers			<0.001	<0.001	0.11
Male (*n* = 71)	1.5 ± 2	1.0 ± 1			
Female (*n* = 230)	3.0 ± 3	1.9 ± 2			
Snacks[c]			0.57	<0.001	0.88
Male (*n* = 71)	10.0 ± 9	6.1 ± 5			
Female (*n* = 230)	9.5 ± 8	5.8 ± 5			
French Fries			0.03	0.003	0.003
Male (*n* = 71)	14.3 ± 12	14.3 ± 13			
Female (*n* = 230)	8.9 ± 7	14.2 ± 14			
Donuts/Cakes			0.41	<0.001	0.38
Male (*n* = 71)	8.8 ± 6	6.7 ± 5			
Female (*n* = 230)	9.0 ± 6	7.6 ± 6			
Ice Cream			0.96	<0.001	0.96
Male (*n* = 71)	6.8 ± 6	3.0 ± 3			
Female (*n* = 230)	7.9 ± 7	4.1 ± 4			
Candy			0.26	0.23	0.50
Male (*n* = 71)	4.8 ± 4	4.6 ± 4			
Female (*n* = 230)	5.6 ± 5	5.0 ± 5			
Margarine			0.13	<0.001	0.80
Male (*n* = 71)	0.9 ± 1	0.5 ± 1			
Female (*n* = 230)	1.2 ± 2	0.7 ± 1			
Butter			0.38	<0.001	0.38
Male (*n* = 71)	1.1 ± 1	0.5 ± 1			
Female (*n* = 230)	0.8 ± 1	0.4 ± 1			
Mayo			0.72	<0.001	0.72
Male (*n* = 71)	2.3 ± 3	1.6 ± 2			
Female (*n* = 230)	1.9 ± 2	1.3 ± 2			
Barbecue Sauce			0.001	0.86	0.001
Male (*n* = 71)	2.9 ± 3	3.5 ± 4			
Female (*n* = 230)	1.6 ± 2	0.9 ± 2			

Salt (added)			0.04	0.10	0.59
Male (*n* = 71)	0.1 ± 0	0.1 ± 0			
Female (*n* = 230)	0.2 ± 0	0.1 ± 0			
Juice			0.50	0.55	0.10
Male (*n* = 71)	148.1 ± 131	142.1 ± 111			
Female (*n* = 230)	138.8 ± 135	132.8 ± 118			
Energy Drinks			0.97	0.002	0.73
Male (*n* = 71)	0.6 ± 2	1.4 ± 2			
Female (*n* = 230)	0.7 ± 2	1.3 ± 4			
Soft Drinks			0.038	0.32	<0.001
Male (*n* = 71)	28.8 ± 28	45.3 ± 50			
Female (*n* = 230)	33.9 ± 43	22.7 ± 27			
Beer			<0.001	0.10	0.07
Male (*n* = 71)	84.3 ± 106	102.9 ± 129			
Female (*n* = 230)	16.7 ± 47	15.7 ± 40			
Wine			<0.001	0.01	0.053
Male (*n* = 71)	2.4 ± 4	2.9 ± 5			
Female (*n* = 230)	4.7 ± 9	8.7 ± 14			
Liquor			0.13	<0.001	0.55
Male (*n* = 71)	28.4 ± 37	42.3 ± 52			
Female (*n* = 230)	19.8 ± 26	37.7 ± 48			

All results are shown as mean ± SD
** Significance from 2-way repeated measures ANOVA (Group: sex; Time: pre to post), significantly different with P value <0.05*
[a] *Muffins, scones, sweet rolls, danishes, pop tarts*
[b] *Burgers, hot dogs, sausage/bacon, ribs, tacos, pork, lunch meat, beef, mixed meat dishes*
[c] *Pretzels, chips, tortilla chips*

4.3.4 Macronutrient and Micronutrient Intake

Table 22 displays the macronutrient intake as a percent of total energy intake (kcals) for both males and females. There was a significant group effect seen for both protein and carbohydrates such that males were eating more protein and females were eating more carbohydrates. There was also a

significant time effect for protein and carbohydrates such that both males and females decreased their protein and carbohydrate intake from the beginning to the end of first-year university. Both sexes were also eating within the acceptable macronutrient distribution range (AMDR) for protein and carbohydrates but went just over fat intake by 1% for females and 0.5% for males at their post study intakes. Males also were undereating carbohydrates by 1.8% compared to the AMDR for their post study intakes.

Table 22: Percent macronutrient changes in males and females from beginning to end of first-year university

	Pre %	Post %	Group p*	Time p*	Interaction p*
Fat (9 kcals/g)			0.66	0.49	0.69
Male (*n* = 71)	35.3%	35.5%			
Female (*n* = 230)	35.4%	36.0%			
Protein (4 kcals/g)			<0.001	0.002	0.74
Male (*n* = 71)	16.3%	15.7%			
Female (*n* = 230)	15.0%	14.3%			
Carbohydrates (4 kcals/g)			<0.001	0.004	0.08
Male (*n* = 71)	46.5%	43.2%			
Female (*n* = 230)	49.4%	48.6%			

[1] Acceptable macronutrient distribution Range (AMDR) for males and females aged 19-30yrs [91]. AMDR values for fat is 20-35%, for protein 10-35% and carbohydrates 45-65%.
** Significance from 2-way repeated measures ANOVA (Group: sex; Time: pre to post), significantly different with P value <0.05*

Table 23 displays the select nutrient intakes compared to the recommended dietary allowances (RDA) [12, 42] and their respective percent of recommendations compared to the post study intakes. Post study intakes were chosen to reflect the current diets of these first-year students. Both males and

females were not meeting the recommended values for fibre, vitamin A, vitamin E, vitamin D, potassium and magnesium. Furthermore, females were not meeting the recommended values for vitamin B6, calcium, zinc, iron and total folate. Both males and females were also eating over the upper intake levels for sodium.

Table 23: Select nutrient intake compared to recommended dietary allowance (RDA) values

	Post Study Intake	**RDA 14-18y**	**RDA 19-30y**	**UL**	**% of Recommendation***
Fat (g)					
Male (*n* = 71)	88.3 ± 36	--	--	--	--
Female (*n* = 230)	59.2 ± 24	--	--	--	--
Protein (g)					
Male (*n* = 71)	88.4 ± 40	52	56	--	158%
Female (*n* = 230)	52.1 ± 19	46	46	--	113%
Carbohydrates (g)					
Male (*n* = 71)	235.6 ± 89	130	130	--	181%
Female (*n* = 230)	178.6 ± 68	130	130	--	137%
Fibre (g)					
Male (*n* = 71)	17.4 ± 8	38	38	--	46%
Female (*n* = 230)	13.3 ± 6	26	25	--	53%
Cholesterol (mg)					
Male (*n* = 71)	327.3 ± 161	--	--	--	--
Female (*n* = 230)	193.7 ± 94	--	--	--	--
Vitamin A RAE (mcg)					
Male (*n* = 71)	887.8 ± 452	900	900	3,000 (mcg/d)	99%
Female (*n* = 230)	580.6 ± 266	700	700	3,000 (mcg/d)	83%
Vitamin C (mg)					
Male (*n* = 71)	126.6 ± 73	75	90	2,000 (mg/d)	141%
Female (*n* = 230)	109.2 ± 71	65	75	2,000 (mg/d)	146%

Vitamin K (mcg)					
Male (*n* = 71)	122.4 ± 77	75	120	--	102%
Female (*n* = 230)	90.0 ± 53	75	90	--	100%
Vitamin E (mg)					
Male (*n* = 71)	9.7 ± 4	15	15	1,000 (mg/d)	65%
Female (*n* = 230)	6.2 ± 3	15	15	1,000 (mg/d)	41%
Vitamin D (mcg)					
Male (*n* = 71)	5.0 ± 3	15	15	100 (mcg/d)	33%
Female (*n* = 230)	3.2 ± 2	15	15	100 (mcg/d)	21%
Thiamin B1 (mg)					
Male (*n* = 71)	1.8 ± 1	1.2	1.2	--	150%
Female (*n* = 230)	1.2 ± 1	1.0	1.1	--	109%
Riboflavin B2 (mg)					
Male (*n* = 71)	2.2 ± 1	1.3	1.3	--	169%
Female (*n* = 230)	1.4 ± 1	1.1	1.1	--	127%
Niacin (mg)					
Male (*n* = 71)	23.9 ± 11	16	16	35 (mg/d)	149%
Female (*n* = 230)	14.4 ± 6	14	14	35 (mg/d)	103%
Vitamin B6 (mg)					
Male (*n* = 71)	1.9 ± 1	1.3	1.3	100 (mg/d)	146%
Female (*n* = 230)	1.2 ± 1	1.2	1.3	100 (mg/d)	92%
Calcium (mg)					
Male (*n* = 71)	1077.6 ± 487	1300	1000	2,500 (mg/d)	108%
Female (*n* = 230)	780.0 ± 330	1300	1000	2,500 (mg/d)	78%
Zinc (mg)					
Male (*n* = 71)	12.2 ± 5	11	11	40 (mg/d)	111%
Female (*n* = 230)	7.4 ± 3	9	8	40 (mg/d)	93%
Iron (mg)					
Male (*n* = 71)	14.9 ± 6	11	8	45 (mg/d)	186%
Female (*n* = 230)	9.8 ± 4	15	18	45 (mg/d)	54%
Potassium (g)					
Male (*n* = 71)	2.7 ± 1	4.7	4.7	--	57%
Female (*n* = 230)	2.0 ± 1	4.7	4.7	--	43%

Sodium (g)					
Male (*n* = 71)	3.6 ± 12	1.5	1.5	2.3 (g/d)	240%
Female (*n* = 230)	2.4 ± 1	1.5	1.5	2.3 (g/d)	160%
Magnesium (mg)					
Male (*n* = 71)	319.6 ± 122	410	400	--	80%
Female (*n* = 230)	220.8 ± 83	360	310	--	71%
Vitamin B12 (mcg)					
Male (*n* = 71)	5.5 ± 2	2.4	2.4	--	229%
Female (*n* = 230)	3.2 ± 1	2.4	2.4	--	133%
Phosphorus (mg)					
Male (*n* = 71)	1535.9 ± 659	1250	700	4,000 (mg/d)	219%
Female (*n* = 230)	1011.4 ± 379	1250	700	4,000 (mg/d)	144%
Copper (mg)					
Male (*n* = 71)	1.4 ± 1	0.89	0.9	10 (mg/d)	155%
Female (*n* = 230)	1.0 ± 0	0.89	0.9	10 (mg/d)	111%
Selenium (mcg)					
Male (*n* = 71)	131.7 ± 77	55	55	400 (mcg/d)	239%
Female (*n* = 230)	72.1 ± 27	55	55	400 (mcg/d)	131%
Total Folate (mcg)					
Male (*n* = 71)	334.7 ± 127	330	320	1,000 (mcg/d)	105%
Female (*n* = 230)	237.7 ± 90	330	320	1,000 (mcg/d)	74%

** Using DRI values for 19-30 years old.*

4.3.5 Eating Behaviour Questionnaire

Table 24 displays the eating behaviour questionnaire results for both males and females. Questions followed a Likert scale format answers ranged from 1-5 such that: 1= never, 2 = seldom, 3 = sometimes, 4 = often and 5 = very often. Interactions were present for questions 2 (*Do you try to eat less at meal times than you would like to eat?*), 8 (*How often do you try not to eat between meals because you are watching your weight?*) and 10 (*Do you take into account your*

weight with what you eat?). There were also significant time effects with question 2 (*Do you try to eat less at meal times than you would like to eat?*) and question 14 (*How often do you consume snacks between meals to increase your caloric intake?*). Group effects also existed for questions 1 (*If you have put on weight, do you eat less than you usually do?*) question 4 (*Do you watch exactly what you eat?)* question 11 (*How often do you eat to put on weight?*), question 12 (*How often do you use supplements to put on weight?*), question 13 (*Do you deliberately eat more to become heavier?*) and question 14 (*How often do you consume snacks between meals to increase your caloric intake?*).

Table 24: Eating behaviour questionnaire for both males and females from beginning to end of first-year university

	Pre	Post	Group p*	Time p*	Interaction p*
1. If you have put on weight, do you eat less than you usually do?			0.032	0.98	0.87
Male (*n* = 71)	2.18 ± 1.2	2.19 ± 1.1			
Female (*n* = 230)	2.44 ± 0.9	2.43 ± 1.1			
2. Do you try to eat less at meal times than you would like to eat?			0.072	0.008	0.017
Male (*n* = 71)	1.65 ± 0.7	2.01 ± 1.0			
Female (*n* = 230)	2.02 ± 1.0	2.04 ± 1.0			
3. How often do you refuse food or drink offered because you are concerned about your weight?			0.16	0.065	0.088
Male (*n* = 71)	1.85 ± 1.0	2.09 ± 1.1			
Female (*n* = 230)	2.15 ± 1.0	2.16 ± 1.0			

4. Do you watch exactly what you eat?			<0.001	0.083	0.84
Male (*n* = 71)	3.05 ± 1.0	2.94 ± 1.1			
Female (*n* = 230)	2.56 ± 1.0	2.42 ± 1.0			
5. Do you deliberately eat foods that are slimming?			0.17	0.26	0.90
Male (*n* = 71)	2.11 ± 1.0	2.04 ± 1.0			
Female (*n* = 230)	2.28 ± 1.0	2.19 ± 1.0			
6. When you have eaten too much, do you eat less than usual the following day?			0.30	0.73	0.36
Male (*n* = 71)	1.95 ± 1.1	1.99 ± 1.1			
Female (*n* = 230)	2.14 ± 1.1	2.06 ± 1.0			
7. Do you deliberately eat less in order not to become heavier?			0.24	0.58	0.95
Male (*n* = 71)	1.87 ± 1.2	1.92 ± 1.1			
Female (*n* = 230)	2.03 ± 1.1	2.07 ± 1.1			
8. How often do you try not to eat between meals because you are watching your weight?			0.65	0.45	0.05
Male (*n* = 71)	1.86 ± 1.2	2.07 ± 1.1			
Female (*n* = 230)	2.07 ± 1.0	1.97 ± 1.0			
9. How often in the evenings do you try not to eat because you are watching your weight?			0.16	0.79	0.72
Male (*n* = 71)	1.94 ± 1.1	1.98 ± 1.1			
Female (*n* = 230)	2.15 ± 1.1	2.14 ± 1.1			
10. Do you take into account your weight with what you eat?			0.94	0.40	0.039
Male (*n* = 71)	2.33 ± 1.3	2.57 ± 1.1			

Female (*n* = 230)	2.49 ± 1.1	2.39 ± 1.1			
11. How often do you eat to put on weight?			<0.001	0.24	0.73
Male (*n* = 71)	2.45 ± 1.3	2.35 ± 1.3			
Female (*n* = 230)	1.40 ± 0.8	1.34 ± 0.7			
12. How often do you use supplements to put on weight?			<0.001	0.93	0.18
Male (*n* = 71)	2.05 ± 1.3	1.98 ± 1.3			
Female (*n* = 230)	1.05 ± 0.2	1.11 ± 0.4			
13. Do you deliberately eat more to become heavier?			<0.001	0.98	0.46
Male (*n* = 71)	2.21 ± 0.5	2.17 ± 1.3			
Female (*n* = 230)	1.13 ± 0.4	1.16 ± 0.5			
14. How often do you consume snacks between meals to increase your caloric intake?			<0.001	0.009	0.44
Male (*n* = 71)	2.50 ± 1.2	2.25 ± 1.1			
Female (*n* = 230)	1.71 ± 1.0	1.57 ± 1.0			

All results are shown as mean ± SD
** Significance from 2-way repeated measures ANOVA (Group: sex; Time: pre to post), significantly different with P value <0.05*

4.4 Pearson Correlations

Pearson correlations were performed with the cortisol data, body composition data, and nutrient and food data. Change in cortisol correlated with change in weight in males (r = 0.29; p = 0.014), BMI in males (r = 0.26; p = 0.03) and lean mass (r = 0.33; p = 0.005) in males. For males, wine was significantly correlated with total fat mass change (r = 0.341; p = 0.004). For females, change in energy intake (kcals) was correlated with change in cortisol (r = 0.14; p =

0.041). Correlations were also found for some questions on the eating behavior questionnaire compared to change in salivary cortisol levels in females. Question 6 (*when you have eaten too much, do you eat less than usual the following day?*) was correlated with percent change cortisol (r = 0.16; p = 0.014) and question 7 (*do you deliberately eat less in order not to become heavier?)* was correlated with change in cortisol and percent change cortisol (r = 0.16; p = 0.019 and r = 0.17; p = 0.011, respectively).

4.5 Salivary Cortisol

Table 25 displays the changes in salivary cortisol (ng/ml) from the beginning to the end of first-year university. There were no main effects seen for salivary cortisol levels in males and females. Furthermore, males had a 29% increase and females had a 16% increase in salivary cortisol levels from the beginning to the end of first-year university.

Table 25: Salivary cortisol males and females from beginning to end of first-year university

MEASURE	PRE	POST	% Change	Group p*	Time p*	Interaction p*
Cortisol (ng/ml)				0.10	0.40	0.31
Male (*n* = 71)	3.1 ± 2	3.1 ± 2	29%			
Female (*n* = 230)	3.5 ± 2	3.3 ± 2	16%			

All results are shown as mean ± SD
** Significance from 2-way repeated measures ANOVA (Group: sex; Time: pre to post), significantly different with P value <0.05*

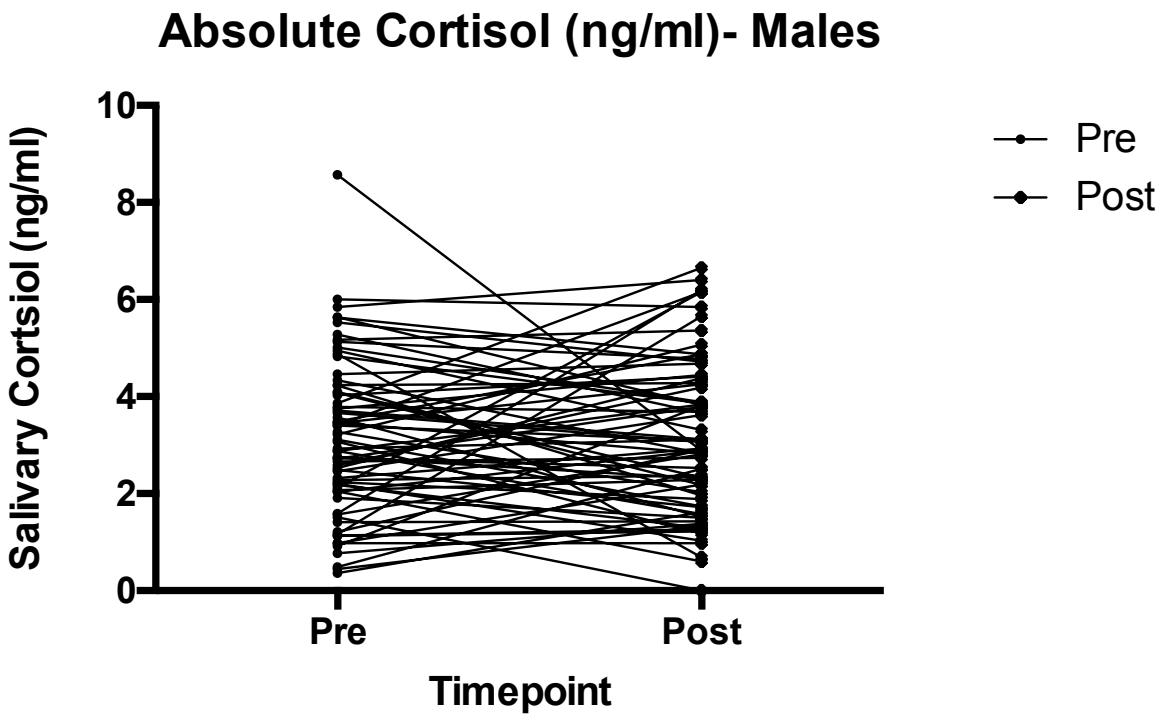

Figure 2: Salivary cortisol (ng/ml) pre and post for males (*n* = 71)

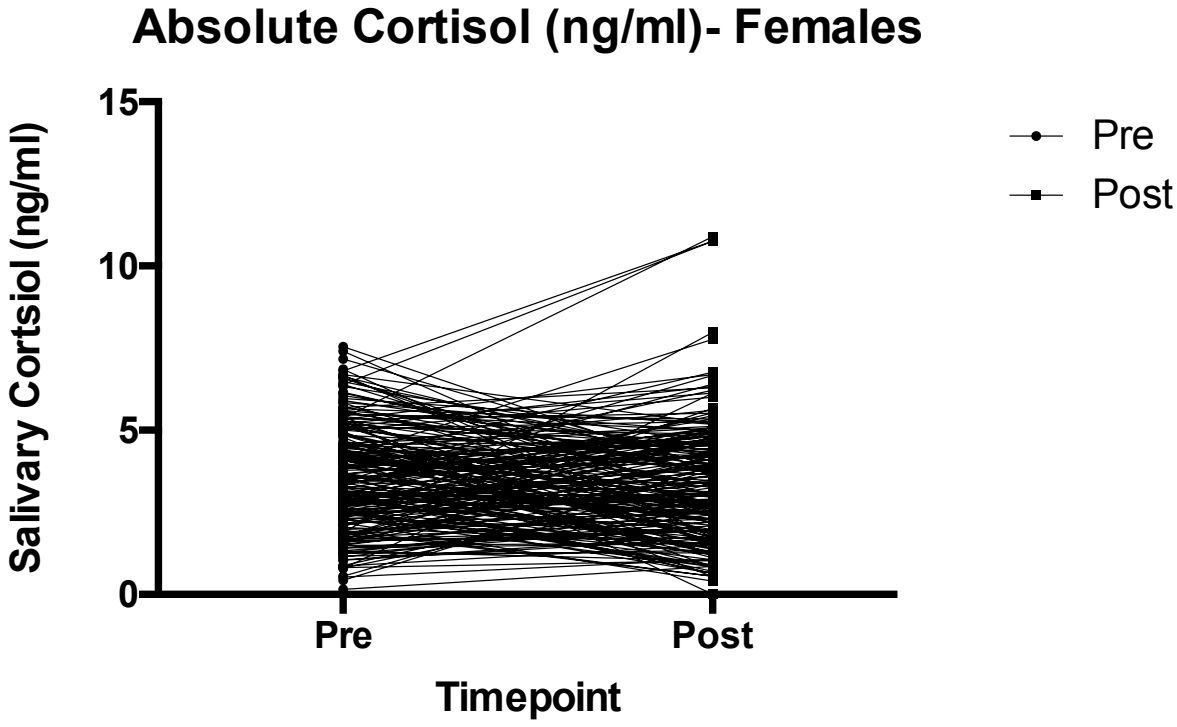

Figure 3: Salivary cortisol (ng/ml) pre and post for females (*n* = 230)

4.6 Energy Expenditure

Table 26 displays the changes in energy expenditure (kcals/d) from the beginning to the end of first-year university. There was a significant group effect that displayed males overall had higher energy expenditure compared to females. Both males and females also had decreases in energy expenditure over the course of first-year university displayed by a significant time effect.

Table 26: Energy expenditure for both males and females from the beginning to the end of first-year university

MEASURE	PRE	POST	Group p*	Time p*	Interaction p*
Energy Expenditure (kcals)			<0.001	<0.001	0.22
Male (*n* = 71)	1490.0 ± 954	1046.9 ± 766			
Female (*n* = 230)	1088.0 ± 800	506.7 ± 430			

All results are shown as mean ± SD
** Significance from 2-way repeated measures ANOVA (Group: sex; Time: pre to post), significantly different with P value <0.05*

CHAPTER 5: DISCUSSION

The present study aimed to investigate the changes in body composition, dietary intake, diet quality and physiological stress that occur among students during their first-year at university, and whether these changes correlate with each other. On many university campuses, the “Freshman 15” is used to described the 15 lbs (6.8 kg) of weight that students purportedly gain over the course of their first-year. Although, current literature has shown that weight gain may be less than half of that, at around 3.3 kg [4]. The main findings from this study were: (1) that there was a significant weight gain observed in both males and females over the course of first-year university. However, when looking more in-depth at the body composition measures, this weight gain reflects a larger increase in lean body mass in males and a larger increase in fat mass in females; (2) there was a change in dietary intake and diet quality over the course of the study characterized by a decrease in total energy intake (kcals), along with a concomitant decrease in overall diet quality. Changes in diet quality were characterized by reductions in consumption of healthy foods as well as increases or no changes in consumption of unhealthy foods; (3) while both males and females decreased overall energy intake, both consumed carbohydrates, protein and sodium, amongst other nutrients above the RDA values. Males and females also consumed inadequate amounts of select nutrients such as fibre, vitamin A, vitamin E, vitamin D, potassium and magnesium (among others) (Table 23).

Our hypotheses were partially confirmed. Both sexes showed an increase in body weight, and, this weight gain came from slightly different tissue sources in females versus males. A significant interaction was present for total weight and lean mass such that males gained more than females. Both males and females gained fat mass. With regards to the second hypothesis, salivary cortisol, the physiological measure of stress, showed no significant absolute change pre to post. However, males showed a 29% increase and females a 16% increase. Absolute change in cortisol did correlate with change in weight in males ($r = 0.29$; $p = 0.014$), BMI in males ($r = 0.26$; $p = 0.03$) and lean mass in males ($r = 0.33$; $p = 0.005$). Change in energy intake (kcals) was correlated with absolute change in cortisol ($r = 0.14$; $p = 0.041$) in females. There were also some correlations found for the eating behavior questionnaires compared to change in salivary cortisol levels in females. It was found that question 6 (*when you have eaten too much, do you eat less than usual the following day?*) was correlated with percent change cortisol ($r = 0.16$; $p = 0.014$) and question 7 (*do you deliberately eat less in order not to become heavier?)* was correlated with both absolute change in cortisol and percent change cortisol ($r = 0.16$; $p = 0.019$ and $r = 0.17$; $p = 0.011$, respectively). In regards to the third hypothesis, the sample did display some changes in eating behaviours (Table 24). Interaction effects were present for question 2 (*Do you try to eat less at meal times than you would like to eat?*) such that males were more likely to eat less at meal times than females by the end of first-year, question 8 (*How often do you try not to eat between meals because*

you are watching your weight?) such that males were more likely to not eat between males than females because they were watching their weight, and question 10 (*Do you take into account your weight with what you eat?)* such that males were more likely to take their weight into account when choosing what to eat compared to females. These significant interactions demonstrate that males were more conscious of what they were eating and when they were eating which could account for the larger increase in healthy weight (i.e. lean mass) seen in males.

5.1 Anthropometric and Body Composition

When looking at both anthropometric and body composition measurements, it was found that both male and female first-year students had a significant increase in body weight (kg). It was previously shown that weight gain can range anywhere between 0.73 kg to 3.99 kg for both sexes [4, 53, 91-93]. When looking at weight gain during this study, males gained 3.7 kg, while females gained 1.6 kg. The findings of this study are consistent with previous literature that weight gain does indeed range between 1-4 kg, and that this gain is below the commonly believed “Freshman 15” (6.8 kg) [94].

Not only did our study measure body weight, but it also measured body composition. It is important to measure body composition to get a better idea of the tissue compositional changes that students undergo, and whether they are healthy (e.g. lean mass increases) or not (e.g. fat mass increases). Studies that

examined weight gain in males have shown that males have a larger increase in weight compared to females [2, 4, 54]. When looking further into body composition measurements from this study, we demonstrated that although males and females gained both types of weight (lean mass and fat mass), males gained 2.9 kg of lean body mass (and 1.3 kg of fat mass) while females gained 1.4 kg of fat mass (and only 1 kg of lean mass). This increase in fat mass in females has been previously shown by Butler et al, 2004, where 54 female first-year students gained significant body weight (from an increase in fat mass) while also significantly decreasing total energy intake [59]. The increase in lean body mass in males has yet to be seen in prior research. Furthermore, when male subjects did gain weight, this weight gain was from an increase in body fat percent rather than lean body mass [4, 8].

Body composition and anthropometric measurements for males and females were further stratified by living arrangement, and Faculty. It has been previously discussed that first-year students who live and dine on campus are more susceptible to weight gain [2, 57, 95]. This may be because one of the largest changes that occur in first-year university is the change in students' environment with respect to food [61, 95]. Some of these changes may be due to a greater variety and choice in food selection, a decrease in parental influence on diet and different social circumstances of eating which all have been shown to have an influence on dietary intake and weight changes [2, 95]. When comparing body composition and anthropometric measurements for students who lived at

home, in residence and in a student house, no significant interactions were seen for any of the composition measures regardless of living arrangement (Table 9 and Table 10). This may be due to the smaller group sizes after stratification of the sample.

This is the first study, to our knowledge, that has looked at weight gain and body composition change based on Faculty. It was hypothesized that students in applied health sciences (AHS) would have a more favourable outcome for body composition and body weight changes due to the health-orientated nature of their programs. However, when looking at the body composition measurements, there were only interaction effects for height and hip circumference in males and none in females. Despite this, no significant pairwise differences were seen. This contradicts our earlier thought that students in AHS would have positive body composition changes due to knowledge that they acquire over the course of first-year from health-oriented introductory classes. This may also be due to the smaller group sizes after stratification of the sample.

5.2 Dietary Intake

5.2.1 Select Nutrients

When looking at dietary habits and nutrition in first-year students, one of the important outcome measures is to analyze the daily intake of both macronutrients and micronutrients. Studies that have assessed dietary intake using either 24hr recalls or food logs/diaries found no differences in dietary intake over the course

of first-year university [7, 8], whereas studies that have used FFQs to quantify dietary intake changes found significant decreases in total energy intake (kcals) and decreases in macronutrients (fat, carbohydrates, protein) [59, 96]. Just as in Butler et al., 2004 [59], our study found a significant decrease in total daily energy intake in males (2711 kcals to 2270 kcals) and females (1850 kcals to 1476 kcals). Since there was a decrease in total energy intake, most macronutrients and micronutrients also significantly decreased in both sexes. Caffeine was the only nutrient that did not change, and alcohol was the only nutrient that increased in both sexes.

An interesting finding from this study pertained to alcohol intake. Even when total energy intake significantly decreased, alcohol (mg) significantly increased represented by a significant time effect. A significant group effect was also present where males, in general, were consuming more alcohol than females. When looking at this with respect to total energy intake, this means that alcohol represented a higher proportion of the total energy intake (which decreased throughout the study) during university. When looking at data from the FFQ, specifically the food frequency and grams data (staples of an unhealthy diet), an increase in the consumption of beer, wine and liquor was shown which relates to the total increase in alcohol intake. This finding is consistent with other studies [59, 74, 96-98]. The increase in alcohol intake may be a factor that could help explain the increase in body weight and fat that was demonstrated in both sexes since alcohol is the second most energy-dense macronutrient, it has an appetite-

enhancing effect, it is less satiating because it is a liquid rather than a solid food, and its calories are not well compensated for resulting in a greater energy intake [74, 98-100]. Furthermore, it has been shown than excess calories from alcohol are more likely to be deposited as abdominal fat than fat elsewhere in the body [101]. Increased abdominal fat is associated with chronic disease such as heart disease and diabetes [81, 101, 102]. In our study, males showed a significantly greater increase in umbilicus circumference than females. This may be related to their increased alcohol intake (although correlations were not significant). Indeed, wine intake was significantly positively correlated with fat mass change in males. Similar to our study, a study done in 54 female students also showed a significant weight gain despite a reduction in total energy intake [59]. The same study showed a significant increase in alcohol intake despite the decrease in total energy intake [59]. Therefore, the weight (fat) gain may relate to alcohol intake in both studies.

Nutrient intake was also stratified by the same factors as body composition (living arrangement and Faculty). It is widely accepted that students who live in residence or a student house will undergo more undesirable changes pertaining to dietary intake and body composition as compared to those students who continue to live at home [57, 95]. This may be because students who live on campus have less parental influence and more social pressure which leads to a lower quality dietary intake [95, 103]. Furthermore, it is believed that students who are eating on campus, compared to those who eat at home will undergo

further deleterious dietary intake and dietary habit changes [2, 104] possibly because of the greater availability and lower cost of lower quality foods including pizza, French fries, hamburgers, chips and other snacks. For example, it has been shown that students who move away from home have a decreased consumption of fruit, vegetables and meat and an increased consumption of sugar and fast food compared to those who live at home [100]. From Table 14, total sugars displayed a significant interaction for males such that sugars decreased in males living in a student house and residence but increased for those living at home. The interaction for caffeine approached significance such that those in residence increased caffeine intake while those at home or in a student house decreased caffeine intake. From Table 15, there were significant interactions for calories, protein, carbohydrates, fibre, alcohol and total sugars. Calories also showed a significant time effect demonstrating that those in residence and a student house decreased their calories more than those living at home. This may relate to the fact that at home, hearty meals may be prepared for the student. In addition, alcohol had a significant group effect and interaction showing that students in residence had greater intakes at the start of university and increased their alcohol consumption more than those living at home or in a student house. This is consistent with previous research that living on campus is associated with an increase in students' alcohol intake likely due to availability and social pressures [96, 97].

Much like body composition, there is little to no research provided on

different Faculties and how this may affect dietary intake and dietary habits during first-year university. There were no significant interactions based on Faculty of study for males or females. Thus, Faculty of study likely does not affect different dietary intakes during first-year university.

5.2.2 Data on Food Frequency from the FFQ

Only one other study has looked at food intake frequency similar to what we did but in a different population [3]. Takomana et al [3] had previously looked at food frequencies in a South African population, however the results may not be applicable to a Canadian population since most foods eaten are culturally different. In our study, both males and females displayed decreases in healthy foods and either increases or no changes in unhealthy foods which indicates an overall decrease in diet quality. Looking at alcohol intake as an example, for males, there was a 22% decrease in the percentage of students that never drank beer and 47% decrease in the percentage of students that never drank liquor. This indicates that there was an increase in male students that consumed alcohol from pre to post study. Females also followed the same trend with wine and liquor. There was a 30% decrease in the percentage of students who never drank wine and a 28% decrease in the percentage of students who never drank liquor from pre to post. These trends in the frequency of intake of alcohol support the other alcohol results (expressed as mg ethanol or beer/wine/liquor) from the FFQ. Some fruits and vegetables also showed increases in the percentages of

'never being eaten' pre to post in both males and females (Tables 18 and 19). This also supports our other FFQ results.

5.2.3 Grams per Day

5.2.3.1 Staples of a Healthy Diet

A novel aspect of this study was the extent to which dietary intake was analyzed. It is not only important to look at the frequency of foods eaten (Tables 18 and 19), but to combine the frequency with the quantity of foods eaten. The FFQ data output was given as nutrient intake, the frequency of foods eaten as well as a composite measure of the frequency and quantity of foods eaten represented in grams of a food per day. The latter gives the best measure of actual food intake. In addition, by looking at grams of foods per day, we can determine diet quality. Diet quality is an umbrella term used to describe how well an individual's diet conforms to dietary recommendations while remaining healthy, balanced and nutritious in order to help an individual reach optimal health [62]. Previous research in North America demonstrated that overall dietary quality worsens over the course of first-year university such that alcohol, caffeine and snacks increase [5], and fruits, vegetables and nuts decrease resulting in body weight gain [3, 5, 56]. Our study found that both males and females had decreases in consumption of healthy foods such as yogurt, cheese, fibre cereal, oatmeal, vegetables (all vegetables, green salad), tropical fruit (melons, bananas, peaches, other fresh fruit), temperate fruit (berries, apples/pears), beans, steak,

tuna/salmon, nuts and milk. However, when looking at the interactions, it was shown that males decreased their intake of yogurt, fibre cereal, carrots, green salad, oranges, temperate fruits, beans, tuna/salmon and nuts more than females. Males also ate more poultry and other vegetables than females who decreased their intake of both, but the time effects were not significant (only group and interactions). This decrease in consumption of healthier foods may help to explain the increase in body weight and fat mass observed since it is well documented in the literature that fruit and vegetable intake as well as fibre and dairy intake have inverse relationships with body weight and fat mass [69, 105].

5.2.3.2 Staples of an Unhealthy Diet

For males and females, there were significant decreases in sugar cereals, pancakes/pastries, pizza, fried fish, meat dishes, crackers, snacks, donuts/cakes, ice cream, margarine, butter and mayo. Males increased their intake fried chicken, and females increased their intake of French fries. Energy drinks, wine and liquor increased for both. Females also had decreases in barbecue sauce and soft drinks compared to males who increased their intakes of these foods (only group and interactions). Noting an overall decrease in energy intake for both sexes, males maintained their intake of unhealthier foods along with a decrease in healthier foods, whereas females showed a decrease in both. Therefore, both males and females displayed decreases in diet quality, however the patterns of decreased quality were slightly different. It seems that the change

in diet quality, rather than actual energy intake (since total calories decreased for both males and females) is likely partially responsible for the body weight and composition changes seen in these first-year students.

5.3 Eating Behaviour Questionnaire

Research states that over the course of first-year university, students are more at risk for developing eating disorders, disordered eating and poorer eating habits [106-109]. These changes in eating habits may also be more apparent in female rather than male students [110]. In the current study, there were some significant changes in eating behaviors seen in the Dutch Eating Behaviour Questionnaire (DEBQ) which is designed to assess restrained, emotional, and external eating behaviour, which refers to eating due to an external or food-related stimuli regardless of hunger or satiety (Table 24) [90]. Time effects were seen for questions 2 (*do you try to eat less at meal times than you would like to eat?*), and 14 *(How often do you consume snacks between meals to increase your caloric intake?)* such that males and females were making changes that are consistent with eating less. Moreover, snack intake decreased similarly in both sexes, consistent with question 14. Interactions (but not group or time effects) were seen for questions 2 (above), 8 (*how often do you try not to eat between meals because you are watching your weight?*) and 10 (*do you take into account your weight with what you eat?*) demonstrating that at some point, males were more likely to eat less at meal times, eat less in between meals and consider

their weight when they eat. Thus, males seem to be more concerned with what they are eating, and this could account for their greater increase in health weight (i.e. lean body mass) during the year. For female students, question 6 (*when you have eaten too much, do you eat less than usual the following day?*) was correlated with percent change cortisol ($r = 0.16$; $p = 0.014$) and question 7 (*do you deliberately eat less in order not to become heavier?)* was correlated with both change in cortisol and percent change cortisol ($r = 0.16$; $p = 0.019$ and $r = 0.17$; $p = 0.011$, respectively). This may show that female students stress more about eating or that their general stress levels negatively influence their eating patterns (however, the r-values are very small).

5.4 Salivary Cortisol

Stress is one of the largest factors that can affect students during first-year university. Stress can be associated with not only an increase in weight gain, but also have a negative impact on dietary intake and dietary habits [111-113]. Increased stress levels have been correlated with an increase in the amount of high fat and salty snacks that may been consumed, especially in females [88, 110]. No significant changes were seen in salivary cortisol (ng/ml) from pre to post in both males and females, however, when assessing % change, males and females showed a 29% and 16% increase, respectively. This discrepancy between the absolutely values for cortisol and percent change for cortisol relates to the way percent change is calculated and removing the inter-variability

between participants when looking at percent change rather than absolute change. A relative decrease in cortisol can be no less than -100% reduction whereas a relative increase in cortisol can be greater than +100%. For example, when something goes from 100 to 75 there is a 25% reduction, but when something goes from 75 to 100 there is a 33% increase. So, changes on a percentage basis can be skewed towards the positive. Therefore, based on the individual cortisol responses, more participants had greater increases than decreases contributing to overall positive increases in % change even though the absolute values do not reflect overall increases. Absolute change in cortisol did correlate with change in weight ($r = 0.29$; $p = 0.014$), BMI ($r = 0.26$; $p = 0.03$) and lean body mass ($r = 0.36$, $p = 0.002$) in males. For females although change in cortisol did not correlated with any of the body composition measures, it was shown that absolute change in cortisol correlated to energy intake ($r = 0.14$; $p = 0.04$). This positive correlation in females (albeit, small) shows that the higher the amount of stress, the more females will increase their dietary intake or the lower stress levels, the less they eat. This may help explain the fat mass increase in female students, as previous research shows that during times of high psychological stress, females are more likely to crave and eat high fat and salty snack foods rather than healthier alternatives [89, 114].

5.5 Energy Expenditure

Both male and female students decreased their energy expenditure over the course of first-year university. This was displayed by a significant time effect for males and females ($p < 0.05$). Since energy intake also significantly decreased over the course of first-year, the increase in weight gain that was seen in both males and females could likely have been caused, in part, by the decrease in energy expenditure that was displayed.

CHAPTER 6: CONCLUSION

6.1 General Conclusions

Our results demonstrated that both males and females had a significant increase in body weight after 1st year. When looking at body composition, both males and females had an increase in lean mass and fat mass, but the increase in lean body mass was greater for males. For females, the increase in body weight was due more to an increase in fat mass rather than lean body mass. Thus, although males and females both gained a significant amount of weight, the composition of their gained weight was different. When looking at dietary intake, it was found that total energy intake (kcals) significantly decreased in both sexes. This was accompanied by a decrease in most macronutrients and micronutrients, except for caffeine which stayed the same and alcohol which increased. When looking at specific foods rather than nutrients, there was a decrease in diet quality for both males and females. Both had a decrease in the amount of healthy foods eaten (such as fruits, vegetables and high-quality proteins). Females also had decreases in many unhealthy foods but increases in French fries, energy drinks, wine and liquor. Males showed fewer decreases in unhealthy foods and increases in fried chicken, wine and liquor. Lastly, energy expenditure decreased in both sexes which may also account for the observed changes in body weight and composition. In conclusion, weight gain does occur during first-year university, with males gaining more weight than females characterized by a greater increase in lean mass, but still not to the extent of the

'freshman 15'. Also, although total energy intake decreased, there was an accompanying decrease in diet quality that may help explain (along with the decrease in energy expenditure) the weight gained, particularly in women, who gained more of their weight as fat.

6.2 Strengths

A strength of the study was the large sample size (n = 301). Based on previous literature, a sample size of 100 (males or females) was calculated as sufficient to detect changes in body composition and macronutrient content, with a significance level of 0.05 (2-sided) and a power of 80% [7, 8]. Therefore, our study was sufficiently powered to assess dietary changes for females, and possibly slightly underpowered for males. However, other studies assessing nutrient intake and body composition found significant results with smaller samples sizes [7, 59].

Body composition measurements were also a great asset to the study. Some of the previous research in this area did measure body composition [7, 8, 107], but most only assessed body weight using either self-reported weight and height [5, 109, 115, 116] or simple measures of height and weight in the lab, and did not measure actual body composition [3, 49, 51, 53, 54, 117]. Measuring body composition allowed us to definitively assess where the weight gain was coming from (lean mass vs fat mass). Moreover, we yielded interesting results regarding the composition of the weight gained, and how it differed between

males and females, which we would not have otherwise known if we had just taken a measure of body weight.

Measuring dietary intake in a very in-depth way was another strength of our study. Previous studies have assessed students' dietary intake using either food logs or 24-hour dietary recalls [7, 8, 107], and these methods of assessing dietary intake may be more subject to reporting error or bias, and not be powerful enough to detect changes over long periods of time [17]. The FFQ that was used in this study was a 127 item, semi-quantitative, validated questionnaire, analyzed by the company Nutritionquest. This FFQ is not only powerful enough to detect changes in dietary intake in large populations over the long term [21-23], but it allowed us to look at dietary intake in terms of nutrients and foods (g/d: the composite measure of intake frequency and quantity) which allowed for a detailed measure of diet quality. In particular, one great benefit of using the FFQ method to assess dietary intake in this study is the ability to assess alcohol intake as a nutrient (mg of ethanol) and as its food/drink source such as liquor, beer, and wine. Since the FFQ asks questions about many details including cooking/preparation methods, the FFQ provides information that other dietary assessment methods may overlook or not be sensitive enough to consider (unless the participant is directly asked to record these details). Lastly, even though we used an American company's FFQ, they analyzed our FFQ using a new Canadian nutrient database. This, therefore, did not compromise the accuracy of our assessment and made it more relevant to the Canadian diet

since some foods in the USA have different nutrient compositions than those in Canada, in particular, fortified foods.

6.3 Limitations

The largest limitation of the study was the diversity within the study sample for both sex and race/ethnicity. Of the 301 first-year students, 76.4% were female and 23.6% were male. Previous research has shown that males and females gain different amounts of weight, and have different dietary intake changes during first-year university [7, 8]. Although we did detect different patterns of change for each sex, it likely would have been better to have equal numbers of male and female subjects. This was particularly problematic when stratification was done to detect changes in different demographic factors (such as those who lived in residence, those who lived at home versus a student house off campus) since the sample sizes of some of the conditions were likely too small to detect differences.

One of the original objectives of our study was to investigate the differences in body composition and dietary intake across different ethnicities. The sample recruited had roughly 75% Caucasian students, while the remaining 25% represented several different ethnicities such as black/African American, Spanish/Hispanic/Latino, South Asian, Native Canadian, etc. Previous literature has shown that ethnicity and race play a role in first-year weight gain [50, 118,

119]. Unfortunately, the lack of diversity in our study likely impeded the detection of any ethnic differences in body composition or diet.

6.4 Future Directions

Since changes were detected in body composition but also in dietary intake and diet quality over the year, we need to educate future first-year students on how to avoid undesirable weight gain and a decrease in diet quality, and promote a healthy body weight and better dietary choices. This can be done in a few ways. We can prepare informational brochures and hold classes geared towards educating students on topics such as physical activity and diet. Since one of the factors that may contribute to poorer diet quality and weight gain is simply not having the knowledge or skill on how to prepare healthy meals [4], these classes can include topics on how to prepare healthy meals and foods on a budget, how to cook, and how to choose healthy food options while eating on campus.

Information collected and described in this study can also be added to existing programs at Brock that help students adjust to the transition from high school to university life. These programs such as Smart Start, LEAP, and mentor plus, already include information about adopting a healthy lifestyle in university while learning to develop a successful academic career at Brock. A future goal should be to see the results of this study put into practical use by presenting it to first-year students to ensure that they are making healthy choices that can be sustained well into adulthood.

Next steps should also include finding an ethnically diverse sample as well as a larger sample to have sufficient power for stratifications. Lastly, an interesting study to do next would be to have first-year students undergo lessons in proper nutrition and cooking compared to students who do not to detect if providing adequate nutrition knowledge (or not) affects first-year weight gain, food intake and food choices. Presumably, nutrition awareness is one factor contributing to first-year weight gain that can be easily resolved.

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APPENDIX A Additional Information

Cortisol Analysis

Cortisol antibodies (R4866) and corresponding horseradish peroxidase conjugate were obtained from C. Munro of the Clinical Endocrinology Laboratory, University of California, Davis. Steroid standards were obtained from Steraloids, Inc. Newport, Rhode Island. Plates were first coated with 50 µl of antibody stock diluted at 1:8500 in a coating buffer (50 mmol/L bicarbonate buffer pH 9.6). Plates were sealed and stored for 12–14 h at 4 °C. 50 µl wash solution (0.15 mol/L NaCl solution containing 0.5 ml of Tween 20/L) was added to each well to rinse away any unbound antibody, then 50 µl phosphate buffer per well was added. The plates were incubated at room temperature for 2 hours before adding standards, samples, or controls. For the hormone, two quality control salivary samples at 30% and 70% binding (the low and high ends of the sensitive range of the standard curve) were prepared. 50 µl cortisol horseradish peroxidase conjugate were added to each well, with 50 µl of standard, sample, or control. After plate loading, plates remained incubated for 1 h. Next, the plates were washed with 50µl wash solution and 100µl of a substrate solution of citrate buffer, H_2O_2 and 2,2′-azino-bis [3-ethylbenzthiazoline-6-sulfonic acid) was added to each well and the plates were covered and incubated while shaking at room temperature for 30–60 min. The plates were then read with a single filter at 405nm on the microplate reader (Titertek multiskan MCC/340). Blank absorbances were obtained, standard curves generated, a regression line was fit

to the sensitive range of the standard curve (typically 40 – 60 % binding) and samples were interpolated into the equation to get a value in pg per well.

APPENDIX B Questionnaires

Appendix B-1 General Health and Demographic Questionnaire

ID # _____

Transition Study – BREB# 13-297

General Health and Demographics Questionnaire

Your responses to this questionnaire are confidential. You may refuse to answer any of the following questions.

Contact Information

Full Name: _____

Location of High School _____

Phone number (_____)_____

E-mail address (please print clearly)

_____

General/Demographic Information

Today's date: _____

Age: _____

Date of Birth: _____

Country of Birth: _____

Race/Ethnicity. Please choose **one or more** of the following. Are you:

White

Aboriginal (e.g. Inuit, Métis, First Nations)

South Asian (e.g., East Indian, Pakistani, Sri Lankan, etc.)

Chinese

Black

Filipino

Latin American

Arab

Southeast Asian (e.g., Vietnamese, Cambodian, Malaysian, Laotian, etc.)

West Asian (e.g., Iranian, Afghan, etc.)

Korean

Japanese

Other - Specify

Current living arrangements (e.g. house with other students, residence, at home with family):

_____

_____

Describe your commute to Brock:

_____

_____

High School you attended:

_____

City you lived in while at High School:

_____

Living arrangements while at High school:

_____

Please indicate if you have ever been diagnosed with any of the following conditions.

Condition	**Tick if YES**	**Age at Diagnosis**
High cholesterol		
High blood pressure		
Depression		
Anxiety disorder		
Bulimia		
Anorexia		
Chest pain or shortness of breath		
Kidney problems		
Food allergies, specify_____		
Other allergies, specify_____		
Asthma		
Diabetes		
Cancer, specify_____		
Crohns/Ulcerative Colitis		

Irritable Bowel Syndrome		
Ulcer		
Thyroid conditions		
Celiac disease		
Arthritis		
Osteoporosis/Osteopenia		
Broken bone (which bone(s)?)		
Other condition, specify_____		

What medications/supplements have you taken within the **last few days**? Indicate whether you habitually (over the last few months) take any of the mentioned medications or supplements.

Medication name	**Reason**	**Amount**	**Habitually?**

What vitamins, minerals, herbal supplements or other nutritional supplements have you taken within the **last few days** (i.e., multivitamin, protein powder, gingko)?

Supplement Name	Reason	Amount	Habitually?

Do you **currently** smoke (at least 1 cigarette per day for 1 month or longer)?

❑ Yes ❑ No

If yes, how many years have you been smoking? _____

If yes. how many cigarettes do you smoke per day? _____

Are you a **past** smoker (have previously smoked at least 1 cigarette per day for 1 month or longer but have not smoked at least 1 cigarette per day in the last month)?

❑ Yes ❑ No

If yes, when did you quit (approximate date)? _____

how many years did you smoke? _____

how many cigarettes did you smoke per day? _____

Please list any food restrictions (e.g., salt, fat, carbohydrate, etc.) or special diets you are have been on in the **last few months** (e.g., Atkins, South Beach, vegan) and the reason (e.g., health, religious or other reasons).

Food Restrictions/ Special Diet	**Reason**	**How long?**

Please answer the next few questions about your sleep patterns over the last 4 weeks.

Generally, how many hours a night do you sleep?

Weekday: _____

Weekend: _____

Is this enough sleep for you? _____

Describe the quality* of your sleep (circle one):

*How often you get up, tossing and turning, restlessness, etc.

bad mediocre good very good excellent

Describe the time it takes you to currently fall asleep (circle one):

Takes a long time usual time takes little time

Describe the way you currently awaken from a night's sleep (circle one):

Still very tired feeling somewhat rested feeling very well rested

Stay in bed a long time usual routine (maybe press snooze once) get right out of bed

Are you tired right now? _____

Thank You!

Appendix B-2 Eating Behavior Questionnaire

ID # _____

Transition Study – BREB#13-297

Eating Behavior Questionnaire

Please respond to the following questions by circling the appropriate number according to the following scale:

Never = 1
Seldom = 2
Sometimes = 3
Often = 4
Very Often = 5

1. If you have put on weight, do you eat less than you usually do?	1	2	3	4	5
2. Do you try to eat less at meal times than you would like to eat?	1	2	3	4	5
3. How often do you refuse food or drink offered because you are concerned about your weight?	1	2	3	4	5
4. Do you watch exactly what you eat?	1	2	3	4	5
5. Do you deliberately eat foods that are slimming?	1	2	3	4	5
6. When you have eaten too much, do you eat less than usual the following day?	1	2	3	4	5
7. Do you deliberately eat less in order not to become heavier?	1	2	3	4	5
8. How often do you try not to eat between meals because you are watching your weight?	1	2	3	4	5
9. How often in the evenings do you try not to eat because you are watching your weight?	1	2	3	4	5
10. Do you take into account your weight with what you eat?	1	2	3	4	5
11. How often do you eat to put on weight?	1	2	3	4	5
12. How often do you use supplements to put on weight?	1	2	3	4	5
13. Do you deliberately eat more to become heavier?	1	2	3	4	5
14. How often do you consume snacks between meals to increase your caloric intake?	1	2	3	4	5

Appendix B-3 Food Frequency Questionnaire

FOOD AND ACTIVITY QUESTIONNAIRE

RESPONDENT ID #

TODAY'S DATE

	DAY	YEAR
Jan		
Feb		
Mar		2014
Apr		2015
May		2016
Jun		2017
Jul		2018
Aug		2019
Sep		2020
Oct		2021
Nov		2022
Dec		2023

ABOUT THIS SURVEY

Please answer each question as best you can. Estimate if you aren't sure.

- **DETACH THE LAST PAGE OF THIS BOOKLET.** These are your portion pictures.
- **USE ONLY A NUMBER 2 PENCIL.**
- **FILL IN THE CIRCLES COMPLETELY** and erase completely if you make any changes.

ABOUT YOU

SEX
- Male
- Female

If female, are you pregnant or breast feeding?
- No
- Yes
- Not female

AGE

WEIGHT pounds

HEIGHT feet inches

PROOF

INSTRUCTIONS

This form is about the foods you usually eat. Think about your intake over the last 6 months. This includes all meals or snacks, at home, in a restaurant, or carry-out.

Please tell us...

1. **HOW OFTEN,** on average, did you eat the food?
   DO NOT SKIP any foods. Mark "Never" if you didn't eat any of the food.
2. **HOW MUCH** of the food did you usually eat on the days you ate it?
   Sometimes we ask "how much" as A, B, C or D. **LOOK AT THE PORTION PICTURES.**
   Pick the picture that looks the most like the serving size you usually eat.
   (If you don't have pictures: A=1/4 cup, B=1/2 cup, C=1 cup, D=2 cups.)
3. **WHAT TYPE?** For some foods we ask the type (low-fat, low-sugar...) near the end of the survey.

EXAMPLE: This person drank orange juice twice a week, and had one glass each time.
Once a week this person ate a "C"-sized serving of cold cereal (about 1 cup).

	HOW OFTEN in the past 6 months? NEVER	A FEW TIMES PER 6 MONTHS	ONCE per MONTH	2-3 TIMES per MONTH	ONCE per WEEK	2 TIMES per WEEK	3-4 TIMES per WEEK	5-6 TIMES per WEEK	EVERY DAY	HOW MUCH on those days? SEE PORTION SIZE PICTURES FOR A-B-C-D
Orange juice	○	○	○	○	○	●	○	○	○	How many glasses ● 1 ○ 2 ○ 3 ○ 4
Cold cereal	○	○	○	○	●	○	○	○	○	Which bowl ○ A ○ B ● C ○ D

PLEASE DO NOT WRITE IN THIS AREA

SERIAL #

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EGGS and DAIRY FOODS	NEVER	A FEW TIMES PER 6 MONTHS	ONCE per MONTH	2-3 TIMES per MONTH	ONCE per WEEK	2 TIMES per WEEK	3-4 TIMES per WEEK	5-6 TIMES per WEEK	EVERY DAY	HOW MUCH on those days? SEE PORTION SIZE PICTURES FOR A-B-C-D
Breakfast sandwiches or breakfast burritos with eggs or meat										How many sandwiches in a day: 1 2
Other eggs like scrambled or boiled, or quiche (not egg substitutes)										How many eggs a day: 1 2 3 4
Yogurt (not frozen yogurt)										Which bowl or glass: B C D
Cottage cheese, ricotta cheese										How much: A B C D
Cream cheese, sour cream, dips										How many tablespoons: 1 2 3 4
Cheese, sliced cheese, cheese spread, including in sandwiches and quesadillas										How many slices: 1 2 3 4
CEREALS, GRAINS, BREADS										
Cold cereals, ANY KIND, like corn flakes, fiber cereals, sweetened cereals										Which bowl: B C D
Oatmeal, or whole grain cereal like Wheatena or Ralston										Which bowl: A B C D
Grits, cream of wheat, cornmeal mush										Which bowl: A B C D
Milk or milk substitutes on cereal										
Brown rice, or dishes made with brown rice										How much in a day: B C D
White rice, or dishes made with rice, like rice and beans										How much in a day: B C D
Pancakes, waffles, French toast, crepes										How many: 1 2 3 4
Breakfast pastries, like muffins, scones, sweet rolls, Danish, Pop Tarts, pan dulce										How many pieces: 1 sm 1 med 2 3
Biscuits, not counting breakfast sandwiches										How many: 1 sm 1 med 2 3
Corn bread, corn muffins, hush puppies										How many pieces in a day: 1/2 1 2 3
Hamburger buns, hotdog buns, submarine or hoagie buns										How many buns in a day: 1/2 1 2 3
Bagels or English muffins, dinner rolls, pita, naan										How many: 1/2 1 2 3
Tortillas (not counting in tacos or burritos)										How many in a day: 1 2 3 4
Any other bread or toast, including white, dark, whole wheat, and what you have in sandwiches										How many slices in a day: 1 2 3 4
VEGETABLES										
Broccoli, Chinese broccoli, or Brussels sprouts										How much: A B C D
Carrots and mixed vegetables containing carrots										How much: A B C D
Corn										How much: A B C D
Green beans, string beans, green peas										How much: A B C D
Cooked greens like spinach, collards, turnip greens, kale, mustard greens										How much: A B C D

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	NEVER	A FEW TIMES PER 6 MONTHS	ONCE per MONTH	2-3 TIMES per MONTH	ONCE per WEEK	2 TIMES per WEEK	3-4 TIMES per WEEK	5-6 TIMES per WEEK	EVERY DAY	HOW MUCH on those days? SEE PORTION SIZE PICTURES FOR A-B-C-D
Cabbage, cole slaw, Chinese cabbage	○	○	○	○	○	○	○	○	○	How much ○ A ○ B ○ C ○ D
Green salad with lettuce or raw spinach	○	○	○	○	○	○	○	○	○	How much ○ 1/2 cup ○ 1 cup ○ 2 cups ○ 3+ cups
Raw tomatoes	○	○	○	○	○	○	○	○	○	How much ○ 1/4 ○ 1/2 ○ 1 ○ 2
Salad dressing	○	○	○	○	○	○	○	○	○	How many tablespoons ○ 1 ○ 2 ○ 3 ○ 4
Avocado, guacamole	○	○	○	○	○	○	○	○	○	How many tablespoons ○ 1 ○ 2 ○ 3 ○ 4
Sweet potatoes, yams	○	○	○	○	○	○	○	○	○	How much ○ A ○ B ○ C ○ D
French fries, home fries, hash browns, tater tots	○	○	○	○	○	○	○	○	○	How much ○ A ○ B ○ C ○ D
Potatoes not fried, like baked, boiled, mashed, or in stew or potato salad	○	○	○	○	○	○	○	○	○	How much ○ A ○ B ○ C ○ D
Any other vegetable, like squash, cauliflower, peppers, okra, nopales	○	○	○	○	○	○	○	○	○	How much ○ A ○ B ○ C ○ D
FRUITS										
How often do you eat the following fruits? Include fresh or frozen fruits. Only include canned or dried fruit when mentioned.										
Watermelon, cantaloupe, honeydew, other melons	○	○	○	○	○	○	○	○	○	How much ○ A ○ B ○ C ○ D
Strawberries or other berries	○	○	○	○	○	○	○	○	○	How much ○ A ○ B ○ C ○ D
Bananas	○	○	○	○	○	○	○	○	○	How many in a day ○ 1/2 ○ 1 ○ 2
Apples or pears	○	○	○	○	○	○	○	○	○	How many in a day ○ 1/2 ○ 1 ○ 2
Oranges, tangerines, grapefruit	○	○	○	○	○	○	○	○	○	How many ○ 1/2 ○ 1 ○ 2
Peaches and nectarines	○	○	○	○	○	○	○	○	○	How many ○ 1/2 ○ 1 ○ 2
Any other fresh fruit, like grapes, plums, mango, fruit salad	○	○	○	○	○	○	○	○	○	How much ○ A ○ B ○ C ○ D
Raisins, dates, other dried fruit	○	○	○	○	○	○	○	○	○	How much ○ A ○ B ○ C
Canned fruit, like applesauce, fruit cocktail, canned peaches or pineapple	○	○	○	○	○	○	○	○	○	How much ○ A ○ B ○ C ○ D
BEANS, TOFU, and MEAT SUBSTITUTES **Include those eaten alone, or in mixed dishes like burritos, chili, stir-fry, salad**										
Refried beans, bean burritos, or hummus	○	○	○	○	○	○	○	○	○	How much ○ A ○ B ○ C ○ D
Pinto beans, black beans, kidney beans, baked beans, lentils	○	○	○	○	○	○	○	○	○	How much ○ A ○ B ○ C ○ D
Tofu or tempeh	○	○	○	○	○	○	○	○	○	How much ○ A ○ B ○ C ○ D
Meat substitutes, like veggie burgers, veggie chicken, vegetarian hot dogs or vegetarian lunch meats	○	○	○	○	○	○	○	○	○	How much ○ A ○ B 1 patty or dog ○ C ○ D

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SOUPS, MIXED DISHES, and NOODLES	NEVER	A FEW TIMES PER 6 MONTHS	ONCE per MONTH	2-3 TIMES per MONTH	ONCE per WEEK	2 TIMES per WEEK	3-4 TIMES per WEEK	5-6 TIMES per WEEK	EVERY DAY	HOW MUCH on those days? SEE PORTION SIZE PICTURES FOR A-B-C-D
Split pea, bean, or lentil soup	○	○	○	○	○	○	○	○	○	Which bowl: B C D
Vegetable soup, vegetable beef soup, or tomato soup	○	○	○	○	○	○	○	○	○	Which bowl: B C D
Any other soup, including chicken noodle, cream soups, Cup-A-Soup, ramen	○	○	○	○	○	○	○	○	○	Which bowl: B C D
Pizza or pizza pockets	○	○	○	○	○	○	○	○	○	How many slices: 1 2 3 4
Macaroni and cheese	○	○	○	○	○	○	○	○	○	How much: B C D
Spaghetti, lasagna, other pasta with tomato sauce	○	○	○	○	○	○	○	○	○	How much: B C D
Other noodles like plain pasta, pasta salad, sopa seca	○	○	○	○	○	○	○	○	○	How much: B C D
Egg rolls, won tons, samosas, empanadas	○	○	○	○	○	○	○	○	○	How many pieces: 1 2 3 4
MEAT and CHICKEN										
Hamburgers, cheeseburgers, turkey burger, at home or from a restaurant	○	○	○	○	○	○	○	○	○	How many: 1 sm 1 lrg 2 3
Hot dogs or dinner sausage like Polish, Italian, chicken apple	○	○	○	○	○	○	○	○	○	How many: 1 2 3 4
Bacon or breakfast sausage	○	○	○	○	○	○	○	○	○	How many pieces: 1 2 3 4
Lunch meats like bologna, sliced ham, sliced turkey, salami	○	○	○	○	○	○	○	○	○	How many slices: 1 2 3 4
Meat loaf, meat balls	○	○	○	○	○	○	○	○	○	How much: B C D
Steak, roast beef, pot roast, including in frozen dinners or sandwiches	○	○	○	○	○	○	○	○	○	How much: A B C D
Tacos, burritos, enchiladas, tamales, tostadas, with meat or chicken	○	○	○	○	○	○	○	○	○	How much: A B C D
Ribs, spareribs	○	○	○	○	○	○	○	○	○	How much: A B C D
Pork chops, pork roast, cooked ham (including for breakfast)	○	○	○	○	○	○	○	○	○	How much: A B C D
Any other beef or pork dish like stew, pot pie, corned beef hash, chili, Hamburger Helper, curry	○	○	○	○	○	○	○	○	○	How much: B C D
Liver, including chicken livers or liverwurst	○	○	○	○	○	○	○	○	○	How much: A B C
Pigs feet, neck bones, oxtails, tongue, chitlins	○	○	○	○	○	○	○	○	○	How much: A B C
Veal, lamb, goat, deer meat, other game	○	○	○	○	○	○	○	○	○	How much: A B C
Fried chicken, including chicken fingers, chicken nuggets, wings, chicken patty	○	○	○	○	○	○	○	○	○	How many medium pieces: 1 2 pcs/ 6 nuggets 3 4
Roasted or broiled chicken or turkey	○	○	○	○	○	○	○	○	○	How much: A B medium piece C D half chicken
Any other chicken or turkey dish, like chicken stew or curry, chicken salad, stir-fry, Chinese chicken dishes	○	○	○	○	○	○	○	○	○	How much: B C D

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FISH, SEAFOOD	NEVER	A FEW TIMES PER 6 MONTHS	ONCE per MONTH	2-3 TIMES per MONTH	ONCE per WEEK	2 TIMES per WEEK	3-4 TIMES per WEEK	5-6 TIMES per WEEK	EVERY DAY	HOW MUCH on those days? SEE PORTION SIZE PICTURES FOR A-B-C-D
Oysters										How much: A B C
Shellfish like shrimp, scallops, crab										How much fish: A B C D
Tuna, tuna salad, tuna casserole										How much of the tuna: A B C
Salmon, mackerel, sea bass, trout, sardines, herring, without breading										How much: A B C D
Fried fish, fish sticks, fish sandwich, breaded fillets										How much: A B C D
Any other fish										How much fish: A B C D
NUTS, SEEDS, SNACKS										
Peanut butter or other nut butters										How many tablespoons: 1/2 1 2 3
Walnuts or flax seeds (don't count flaxseed oil)										How much: 1 Tbsp 2 Tbsp 1/4 cup 1/2 cup
Peanuts, sunflower seeds, other nuts or seeds										How much: A B C D
Energy or protein bars, like Power Bar, Clif, Balance, Luna, South Beach, Atkins										How much: Small Medium Large
Breakfast bars, cereal bars, granola bars (not energy or protein bars)										How many: 1 2 3
Popcorn										How many cups: 1-2 3-6 7-9 10-12
Whole grain crackers, like Wheat Thins, RyeKrisp, Ryvita, Wasa										How much: A B C D
Any other crackers, like saltines, Ritz, Cheez-Its, cheese-filled pretzels										How much: A B C D
Tortilla chips or corn chips, like Fritos, Doritos, corn nuts										How much: A B C D
Any other snack chips, like potato chips, Cheetos, Chex mix										How much: A B C D
SWEETS AND DESSERTS										
Donuts										How many: 1 mini 1 med 2 3
Cake or snack cakes like cupcakes, Twinkies, pound cake, banana bread										How many pieces: 1 sm 1 med 2 3
Cookies, brownies										How many: 1-2 3-4 5-6 7+
Pumpkin pie, sweet potato pie										How many pieces: 1/2 1 2 3
Any other pie or cobbler, including fast food pies, snack pies										How many pieces: 1/2 1 2 3
Ice cream, ice cream bars, frozen yogurt, fast food milkshakes										How much: B C D
Pudding, custard, rice pudding, flan										How much: B C D
Chocolate or other flavored sauces or syrup, on ice cream										How much: 1-2 Tbspn 3-4 Tbspn 1/2 cup

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	NEVER	A FEW TIMES PER 6 MONTHS	ONCE per MONTH	2-3 TIMES per MONTH	ONCE per WEEK	2 TIMES per WEEK	3-4 TIMES per WEEK	5-6 TIMES per WEEK	EVERY DAY	HOW MUCH on those days? SEE PORTION SIZE PICTURES FOR A-B-C-D
Popsicles, jello, frozen fruit bars, slushies, sherbet (don't count sugar-free)	○	○	○	○	○	○	○	○	○	How much: ○ A ○ B ○ C ○ D
Chocolate candy, candy bars like Snickers, Hershey's, M&Ms	○	○	○	○	○	○	○	○	○	How much in a day: ○ 1 mini ○ 1 med ○ 1 lrg ○ 1 king
Any other candy, not chocolate, like hard candy, Lifesavers, Skittles, Starburst, breath mints, chewing gum (NOT sugar free)	○	○	○	○	○	○	○	○	○	How much in a day: ○ 1-2 pcs ○ 1/2 pkg ○ 1 pkg ○ 2 pkgs
SPREADS, SAUCES, OTHER FOODS										
Margarine (not butter) on bread, rice, vegetables, or other foods	○	○	○	○	○	○	○	○	○	How many pats (tsps): ○ 1 ○ 2 ○ 3 ○ 4
Butter (not margarine) on bread, rice, vegetables, or other foods	○	○	○	○	○	○	○	○	○	How many pats (tsps): ○ 1 ○ 2 ○ 3 ○ 4
Mayonnaise, sandwich spreads	○	○	○	○	○	○	○	○	○	How many tablespoons: ○ 1/2 ○ 1 ○ 2 ○ 3
Ketchup, salsa, chili sauce, chili peppers	○	○	○	○	○	○	○	○	○	How many tablespoons: ○ 1/2 ○ 1 ○ 2 ○ 3
Mustard, barbecue sauce, soy sauce	○	○	○	○	○	○	○	○	○	How many tablespoons: ○ 1/2 ○ 1 ○ 2 ○ 3
Gravy, or other rich sauces like Alfredo, white sauce, mole, peanut sauce	○	○	○	○	○	○	○	○	○	How many cups: ○ 1/4 ○ 1/2 ○ 1
Jam, jelly, marmalade	○	○	○	○	○	○	○	○	○	How many tablespoons: ○ 1/2 ○ 1 ○ 2 ○ 3
Pickles, pickled vegetables, sauerkraut, kimchi	○	○	○	○	○	○	○	○	○	How much: ○ A ○ B ○ C ○ D
Salt, added to your food at the table	○	○	○	○	○	○	○	○	○	How many shakes in a day: ○ 1-3 ○ 4-5 ○ 6-7 ○ 8+
BEVERAGES										
Chocolate milk, cocoa, hot chocolate	○	○	○	○	○	○	○	○	○	How many 12 ounce servings: ○ 1/2 ○ 1 ○ 2 ○ 3
Glasses of milk or soy milk, not counting on cereal, in coffee, or chocolate milk	○	○	○	○	○	○	○	○	○	How many 8 ounce servings: ○ 1 ○ 2 ○ 3 ○ 4
Meal replacement drinks like Slim Fast, Ensure, or high protein drinks or powders	○	○	○	○	○	○	○	○	○	How many cans or glasses: ○ 1 ○ 2 ○ 3 ○ 4
Tomato juice, V-8, other vegetable juice	○	○	○	○	○	○	○	○	○	How many 8 ounce servings: ○ 1/2 ○ 1 ○ 2 ○ 3
Real 100% orange juice or grapefruit juice. Don't count orange soda or Sunny Delight.	○	○	○	○	○	○	○	○	○	How many 8 ounce servings: ○ 1/2 ○ 1 ○ 2 ○ 3
Other 100% juices, like apple, grape, 100% fruit blends, or fruit smoothies	○	○	○	○	○	○	○	○	○	How many 8 ounce servings: ○ 1/2 ○ 1 ○ 2 ○ 3
Hi-C, cranberry juice cocktail, Hawaiian Punch, Tang	○	○	○	○	○	○	○	○	○	How many 12 ounce servings: ○ 1/2 ○ 1 ○ 2 ○ 3
Drinks with some juice like Sunny Delight, Knudsen	○	○	○	○	○	○	○	○	○	How many 12 ounce servings: ○ 1/2 ○ 1 ○ 2 ○ 3
Iced tea, homemade, instant or bottled, like Nestea, Lipton, Snapple, Tazo	○	○	○	○	○	○	○	○	○	How many 16-oz. glasses or bottles: ○ 1/2 ○ 1 ○ 2 ○ 3
Gatorade, Powerade, or other sports drinks	○	○	○	○	○	○	○	○	○	How much in a day: ○ 1 16-ounce bottle ○ 1 20-ounce bottle ○ 2 16-ounce bottles ○ 2 20-ounce bottles

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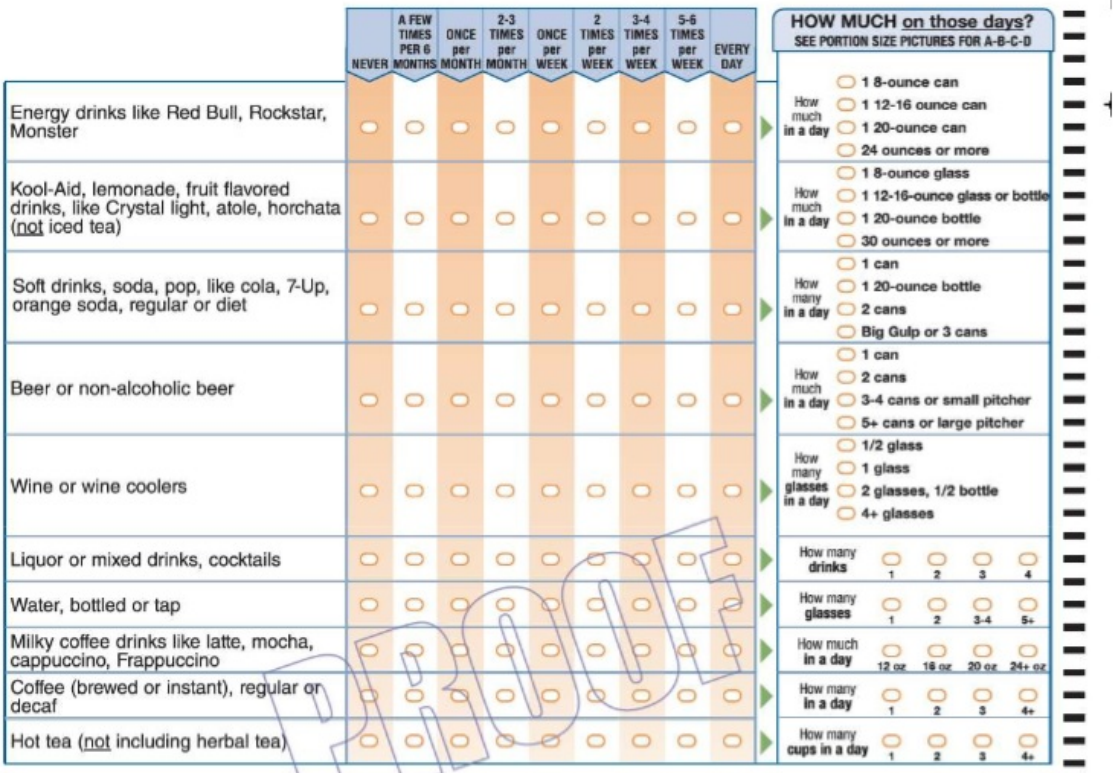

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MILKY COFFEE DRINKS: What kind do you usually drink? MARK ONLY ONE

○ Frappuccino ○ Mocha ○ Latte or cappuccino ○ Café con leche ○ Some of each ○ Don't drink them

What are your milky coffee drinks usually made with? **MARK ONLY ONE**

○ Whole milk ○ Skim milk or non-fat ○ Something else
○ 1 or 2% milk (reduced fat) ○ Soy milk ○ Don't drink

COFFEE: Is your coffee usually regular or decaf? ○ Decaf ○ Regular ○ Both kinds ○ Don't drink coffee

What do you usually add to your regular or decaf coffee? **MARK ONLY ONE**

○ Cream or half-n-half ○ Condensed milk ○ None of these
○ CoffeeMate, non-dairy creamer ○ Any other milk

Do you usually add sugar (or honey) to coffee? ○ No ○ Yes IF YES, how many teaspoons each cup? ○ 1 ○ 2 ○ 3 ○ 4

HOT TEA: Is your hot tea usually regular or decaf? ○ Decaf ○ Regular ○ I drink both kinds ○ Don't drink tea

What do you usually add to your hot tea? **MARK ONLY ONE**

○ Cream or half-n-half ○ Condensed milk ○ None of these
○ CoffeeMate, non-dairy creamer ○ Any other milk

Do you usually add sugar (or honey) to hot tea? ○ No ○ Yes IF YES, how many teaspoons each cup? ○ 1 ○ 2 ○ 3 ○ 4

If you eat the following foods, what type do you usually eat? MARK ONLY ONE ANSWER FOR EACH QUESTION

Milk	○ Whole milk	○ 2% milk	○ 1% milk (low-fat)	○ Skim milk, non-fat	
	○ Soy milk	○ Rice milk	○ Almond milk, other	○ Don't drink	
Slimfast, Ensure, or high protein drinks	○ Slimfast, Ensure, regular	○ Slimfast, Ensure, light or low-carb			
	○ High protein drinks, regular	○ High protein drinks, light or low-carb	○ Don't know/Don't drink		
Real 100% orange or grapefruit juice	○ Calcium-fortified	○ Not calcium fortified	○ Don't know	○ Don't drink	
Iced tea	○ Home-made, no sugar	○ Bottled, no-sugar	○ Don't drink		
	○ Home-made, with sugar	○ Bottled, pre-sweetened			
Drinks like Kool-Aid, lemonade, Crystal Light	○ Low-calorie, sugar-free	○ Regular	○ Don't drink		
Energy drinks like Red Bull, Monster	○ Sugar-free	○ Regular	○ Don't drink		
Soft drinks, soda, pop	○ Diet, low-calorie	○ Regular	○ Don't drink		
Do they usually have caffeine?	○ Has caffeine	○ No caffeine	○ Don't drink		
Beer	○ Regular	○ Light	○ Non-alcoholic	○ Don't drink	
Wine or wine cooler	○ Red wine	○ White wine	○ Both red and white wine	○ Don't drink	
Cheese	○ Low-fat	○ Regular-fat	○ Don't eat		
Yogurt	○ Plain (no sugar or fruit)	○ With fruit or other flavors			
Yogurt	○ Low-fat	○ Non-fat	○ Regular (whole milk)	○ Don't eat	
Salad dressing	○ Low-fat, lite	○ Fat free	○ Regular	○ Oil & vinegar	○ Don't use
Spaghetti or lasagna	○ Meatless	○ With meat sauce or meatballs	○ Don't eat		
Noodles, pasta	○ Rarely whole grain	○ Sometimes whole grain	○ Usually whole grain	○ Don't know/don't eat	
Burgers	○ Hamburger	○ Cheeseburger	○ Turkey burger	○ Don't eat	
Beef or pork	○ Avoid eating the fat	○ Sometimes eat the fat	○ Often eat the fat	○ Don't eat	
Chicken or turkey	○ Avoid eating the skin	○ Sometimes eat the skin	○ Often eat the skin	○ Don't eat	
Hot dogs, dinner sausage	○ Beef or pork	○ Chicken or turkey, low-fat	○ Don't eat		
Lunch meats	○ Beef or pork	○ Chicken or turkey, low-fat	○ Don't eat		
Cakes, snack cakes, cupcakes	○ Low-sugar, low-carb	○ Low-fat	○ Regular-fat	○ Don't eat	
Cookies, brownies	○ Low-sugar, low-carb	○ Low-fat	○ Regular-fat	○ Don't eat	
Ice cream, frozen yogurt	○ Low-sugar, low-carb	○ Low-fat or frozen yogurt	○ Regular	○ Don't eat	
Energy or protein bars	○ High energy	○ High protein	○ Some of each	○ Don't know	○ Don't eat
Bagels, English muffins, rolls	○ White	○ Multi-grain	○ 100% whole wheat	○ Eat all kinds	○ Don't eat
Burger, hot dog, submarine buns	○ White	○ Multi-grain	○ 100% whole wheat	○ Eat all kinds	○ Don't eat
Bread	○ White (not whole grain)	○ 100% whole wheat	○ Don't eat		
	○ Multi-grain, rye, or other brown bread	○ Eat some of each			
Tortillas	○ Corn tortillas	○ Flour tortillas (wheat)	○ Eat all kinds or don't know	○ Don't eat	
Popcorn	○ Air popped, fat-free	○ Low-fat or Light	○ Regular	○ Caramel corn	○ Don't know ○ Don't eat
Crackers, pretzels	○ Low-fat, including RyeKrisp, rice cakes, or plain pretzels		○ Don't know		
	○ Regular-fat crackers or filled pretzels		○ Don't eat		
Mayonnaise or sandwich spreads	○ Low-fat, light	○ Regular	○ Don't eat		

If you eat **cold cereals,** what do you usually eat? Choose **ONE or TWO** that you eat most often. If you usually eat just one kind, only choose one.

○ All Bran Original	○ Cinnamon Toast Crunch	○ Grape Nuts	○ Special K, plain
○ All-Bran Complete, Complete	○ Cocoa Krispies, Pebbles, Puffs	○ Honey Bunches of Oats	○ Special K, flavors
○ Apple Jacks, Cookie Crisp	○ Corn Flakes, Corn Puffs	○ Kashi GOLEAN, Heart to Heart	○ Total
○ Bran Flakes	○ Corn Pops	○ Life	○ Wheaties
○ Cap'n Crunch	○ Fiber-One, Bran Buds	○ Lucky Charms, Fruity Pebbles	○ *Other sweet cereal*
○ Cheerios, plain or Multi-Grain	○ Froot Loops	○ Oatmeal Squares, Oat Bran	○ *Other unsweetened cereal*
○ Cheerios, Honey Nut, flavors	○ Frosted Flakes	○ Raisin Bran	○ *Other whole grain cereal*
○ Chex, Wheat	○ Frosted Mini-Wheats	○ Rice Krispies, puffed rice	○ *Other bran or fiber cereal*
○ Chex, other	○ Granola	○ Shredded Wheat	○ *Don't eat cereal*

Which **fats or oils** are used most often for **cooking or frying** (not baking) in your home? **MARK ONLY ONE OR TWO**

○ Non-stick spray or none	○ Soft tub margarine	○ Corn oil, vegetable oil and blends	○ Other oil
○ Butter or ghee	○ Low-fat margarine	○ Peanut oil	○ Don't know
○ Butter/margarine blend	○ Olive oil	○ Lard, fatback, or bacon fat	
○ Stick margarine	○ Canola oil, safflower oil	○ Vegetable shortening, Crisco	

PLEASE DO NOT WRITE IN THIS AREA

SERIAL #

PROOF

What vitamin supplements do you take fairly regularly?

Multiple Vitamins. Do you take...	HOW OFTEN: DIDN'T TAKE	A FEW DAYS per MONTH	1 DAY per WEEK	2 DAYS per WEEK	3-4 DAYS per WEEK	5-6 DAYS per WEEK	EVERY DAY	FOR HOW MANY YEARS?: LESS THAN 1 YEAR	1-4 YEARS	5-9 YEARS	10+ YEARS
Prenatal vitamins	○	○	○	○	○	○	○	○	○	○	○
Regular One-A-Day, Centrum, "senior" vitamins or house brands of multiple vitamins	○	○	○	○	○	○	○	○	○	○	○
Stress-tabs or B-Complex type	○	○	○	○	○	○	○	○	○	○	○
Antioxidant combination, eye formula	○	○	○	○	○	○	○	○	○	○	○
Single Vitamins or Minerals, taken alone or in combination. Do not count what is in your multiple vitamins above.											
Vitamin A (not beta-carotene)	○	○	○	○	○	○	○	○	○	○	○
Vitamin B-6	○	○	○	○	○	○	○	○	○	○	○
Vitamin B-12	○	○	○	○	○	○	○	○	○	○	○
Vitamin C	○	○	○	○	○	○	○	○	○	○	○
Vitamin D	○	○	○	○	○	○	○	○	○	○	○
Vitamin E	○	○	○	○	○	○	○	○	○	○	○
Folic acid, folate	○	○	○	○	○	○	○	○	○	○	○
Calcium or antacids with calcium, like Tums	○	○	○	○	○	○	○	○	○	○	○
Iron	○	○	○	○	○	○	○	○	○	○	○
Zinc	○	○	○	○	○	○	○	○	○	○	○
Cod liver oil, other fish oils, omega-3, flax seed oil, algae	○	○	○	○	○	○	○	○	○	○	○
Fiber supplements like Benefiber, Metamucil	○	○	○	○	○	○	○	○	○	○	○

PROOF

If you take One-A-Day, Centrum or other types of multiple vitamins, do you usually take types that

○ Contain minerals, iron, zinc, etc. ○ Do not contain minerals ○ Don't know

If you take vitamin C, how many milligrams of **vitamin C** do you usually take, on the days you take it? (Select the closest amount)

○ 100 ○ 250 ○ 500 ○ 750 ○ 1000 ○ 1500 ○ 2000 ○ 3000+ ○ Don't know

If you take vitamin E, how many IUs of **vitamin E** do you usually take, on the days you take it? (Select the closest amount)

○ 100 ○ 200 ○ 300 ○ 400 ○ 600 ○ 800 ○ 1000 ○ 2000+ ○ Don't know

If you take calcium, how many milligrams of **calcium** do you usually take, on the days you take it? (Select the closest amount)

○ 100 ○ 350 ○ 650 ○ 1250+ ○ Don't know

If you take vitamin D, how many IUs of **vitamin D** do you usually take, on the days you take it? (Select the closest amount)

○ 400 ○ 600 ○ 800 ○ 1000 ○ 2000 ○ 3000 ○ 4000 ○ 5000+ ○ Don't know

If you take omega-3 supplements, what type do you usually take? **MARK ALL THAT APPLY**

○ Fish oil ○ Flax oil, hemp oil, other seed oil ○ Krill oil ○ Algae ○ Don't know

SOME LAST QUESTIONS ABOUT YOU

	RARELY	1-2 per WEEK	3-4 per WEEK	5-6 per WEEK	1 per DAY	1 1/2 per DAY	2 per DAY	3 per DAY	4+ per DAY
About how many servings of vegetables do you eat, not counting salad or potatoes? 1 serving = 1/2 cup.	○	○	○	○	○	○	○	○	○
About how many servings of fruit do you eat, not counting juices? 1 serving = 1/2 cup or 1 medium fruit.	○	○	○	○	○	○	○	○	○
How often do you eat foods prepared at home that are cooked or fried in **fat or oil?**	○	○	○	○	○	○	○	○	○

During a regular day, how many **meals and snacks** do you usually eat?

Meals per day	○ 1	○ 2	○ 3	○ 4	○ 5+
Snacks per day	○ 1	○ 2	○ 3	○ 4	○ 5+

PHYSICAL ACTIVITY SURVEY

Think about the last 6 months. How often did you do the activities listed below?

	HOW OFTEN IN THE PAST 6 MONTHS						HOW MUCH TIME ON THOSE DAYS			
	RARELY OR NEVER	A FEW TIMES A MONTH	ONCE OR TWICE A WEEK	3-4 TIMES A WEEK	5-6 TIMES A WEEK	ALMOST EVERY DAY	LESS THAN 30 MINUTES	30-60 MINUTES	1-2 HOURS	3 OR MORE HOURS
Cooking, shopping, light cleaning like doing laundry or dusting, or running errands	○	○	○	○	○	○	○	○	○	○
Slow walking like walking the dog, or light work around the house like watering	○	○	○	○	○	○	○	○	○	○
Work on the job involving standing, like store clerk, or work involving driving (like truck driver)	○	○	○	○	○	○	○	○	○	○
Taking care of children (feeding, dressing), or moderate housework like sweeping, mopping, cleaning the tub	○	○	○	○	○	○	○	○	○	○
Weeding, raking, mowing the lawn, or light house repairs	○	○	○	○	○	○	○	○	○	○
Brisk walking, dancing, hunting or fishing, golf (NOT using a golf cart), or 'friendly' outdoor games like softball	○	○	○	○	○	○	○	○	○	○
Factory work, mechanic, restaurant work, or work involving walking, like mail carrier	○	○	○	○	○	○	○	○	○	○
Construction, painting, feeding livestock, or homecare like caring for an adult family member	○	○	○	○	○	○	○	○	○	○
Heavy work like moving boxes, heavy digging or shoveling snow, farm chores like baling hay, or other HARD labor	○	○	○	○	○	○	○	○	○	○
Exercising at the gym or at home, aerobics, weight training, jogging, or vigorous sports like basketball, soccer, tennis	○	○	○	○	○	○	○	○	○	○
Bicycling or swimming for exercise	○	○	○	○	○	○	○	○	○	○

PILOT

Are you ○ Hispanic or Latino ○ Not Hispanic or Latino ○ Do not wish to provide this information

What race do you consider yourself to be? **MARK ALL THAT APPLY**

- ○ White
- ○ Black or African American
- ○ Asian
- ○ American Indian or Alaska Native
- ○ Native Hawaiian or Other Pacific Islander
- ○ Do not wish to provide this information

Thank you very much for filling out this questionnaire.
Please take a minute to go back and fill in anything you may have skipped.

PLEASE DO NOT WRITE IN THIS AREA

SERIAL #

Appendix C Ethics

Appendix C-1 Consent Form

Faculty of Applied Health Sciences
Department of Kinesiology

Brock University
Niagara Region
500 Glenridge Ave.
St. Catharines, ON
L2S 3A1 Canada
brocku.ca

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

STUDY TITLE: Identifying lifestyle changes that impact students' physical and emotional wellbeing during their first year of university

You are being invited to participate in a research study conducted by the investigators listed below. Prior to participating in this study please read this form to find out about the purpose of our study and what is required of you should you choose to participate. All testing will be carried out in the Nutrition Laboratory (WH144, Brock University) or online.

INVESTIGATORS:	DEPARTMENT:	CONTACT:
Dr. Andrea Josse	**FAHS, Brock University**	**(905) 688-5550 ex. 3502**
Dr. Nota Klentrou	FAHS, Brock University	(905) 688-5550 ex. 4538
Dr. Kimberley Gammage	FAHS, Brock University	(905) 688-5550 ex. 3772
Dr. Bareket Falk	FAHS, Brock University	(905) 688-5550 ex. 4979
Dr. Cameron Muir	FSS, Brock University	(905) 688-5550 ex. 4681

PURPOSE: The purpose of our study is to identify the key health-related issues and lifestyle changes that may occur as students' transition from high school to university and undergo their first year in university. Specifically, we are assessing the changes in nutrition, exercise and sleep habits, stress levels, body image, mental health and anthropometry (body weight and body composition) during this critical period.

INCLUSION CRITERIA: You may participate in this study if you are entering your first year at Brock University, you are between the ages of 17-20, and you speak and understand English.

EXCLUSION CRITERIA: You are not eligible to participate in this study if you are transferring programs within Brock or have already completed a first year of University elsewhere.

STUDY TIMELINE: Should you consent to participate, you will be asked to fill out several surveys online and come to the Nutrition Laboratory on campus (WH144) in the morning hours on two occasions (2 time points). Testing sessions are identical and will be approximately 8 months apart. Thus, the testing sessions will

take place at the start and end of the academic year (September and April). Each of the 2 testing sessions will last approximately 1 hour online and 1 hour in the laboratory. The total time commitment involved will add up to 4 hours. You will be asked to fill out a series of questionnaires online prior to your laboratory visit, and in the lab, you will fill out one more questionnaire asking about eating habits. If preferred, you may request to fill out all surveys in person as opposed to online. You will then have your height, weight, waist circumference, and body composition measured, and you will provide a saliva sample. Two or 3 participants will be scheduled to visit the lab simultaneously, however all measurements will be taken individually and privately, and if requested, by a same-sex investigator. All procedures are detailed below.

DESCRIPTION OF TESTING PROCEDURES: You will be asked to arrive at the Nutrition Laboratory for your scheduled testing session. Please refrain from eating or drinking anything for **4 hours** prior to this testing session. Please refrain from exercise for **12 hours** and from alcohol for **24 hours** prior to this testing session. Students of the study investigators will be facilitating the testing and taking the measures. Specific testing procedures are outlined below.

1. **Questionnaires:** You will be asked to complete questionnaires online (using Fluid Survey) and one questionnaire on paper (the Food Frequency Questionnaire) on three occasions. These questionnaires will ask about your general health and demographics, medical history, exercise, nutrition, sleep habits, stress levels, body image and mental health. Remember that your responses will be kept confidential and that you may choose not to answer any question without penalty. All online data will be stored on Canadian servers and then downloaded to our password protected laboratory computers for further analysis. Only your subject ID will be used as an identifier, i.e. those analyzing the data will not know who filled out the survey, only their subject ID.

2. **Body composition:** We will measure your body composition (% body fat) in two ways on three occasions. The first is using BIA, which stands for “Bioelectric Impedance Analysis”. The BIA assessment requires you to stand on a weight scale and grasp two handles. A mild electrical current (50kHz, 800μA) will pass through your hands to your feet. This current cannot be felt and causes no harm. Valid measurements require abstinence from exercise, alcohol consumption, and eating/drinking for at least 12, 24 and 4 hours, respectively, prior to testing. You will be asked to consume 1 bottle of water (500 mL) at the start of the visit and then void prior to BIA measures being taken. Body composition will also be

assessed using the BodyMetrix system. The BodyMetrix system uses ultrasound to accurately measure fat thickness in your thigh and calculate % body fat. There is no discomfort associated with either measurement.

With bioelectrical impedance analysis (BIA), body composition will be measured by having you stand on a weight scale putting your feet on electrode plates while holding electrode wands in your hands (as mentioned above). With the BodyMetrix ultrasound device, body composition will be measured on the top part of your thigh. Waist circumference will be measured using a standard, retractable, non-metallic tape measure placed at your waist at the level of your belly button. Hip circumference will be measured using the same tape measure across the largest part of your buttocks and below your 'hip bones'.

3. **Saliva sample:** We will ask you to provide a saliva sample at each visit to determine your salivary cortisol (stress hormone) and testosterone levels. Saliva samples must be collected in the morning hours. The samples will be collected using specifically designed cotton ball/swabs which are to be placed between your cheek and teeth. You will hold the swab there for 1 minute and then place it into labeled tubes for storage. You will be asked to follow these additional procedures and answer additional related questions prior to collection:

    a. Avoid foods with high sugar or acidity, or high caffeine content, 4 hours before sample collection.

    b. Document consumption of alcohol, caffeine, nicotine, and prescription/over-the-counter medications as well as physical activity within the prior 12 hours.

    c. Document the presence of oral diseases or injury.

    d. Do not eat a major meal within 60 minutes of sample collection.

    e. Rinse mouth with water to remove food residue and wait at least 10 minutes after rinsing to avoid sample dilution before collecting saliva.

CONFIDENTIALITY: All of your data collected during this study will remain confidential and will be stored in offices and on secured computers to which only the principal and co-investigators have access. You should be aware that the results of this study will be made available to scientists, through publication in a scientific journal but your name and any personal data will not appear in compiling or publishing these results. Electronic and paper data will be kept for 5

years after the date of publication, at which time all information will be destroyed. Additionally, you will have access to your own data, as well as group data when it becomes available and if you are interested. Once the study is completed, if you wish to be contacted to learn of the results of the study and/or to participate in future studies directly relating to this one (e.g. focus groups) please indicate this on the last page of this form.

PARTICIPATION AND WITHDRAWAL: You can choose whether to participate in this study or not and may remove your data from the study if you wish at any time. You may also refuse to answer any questions posed to you during the study and still remain a participant in the study. There will be no effect on your academic standing or standing within the university if you choose to withdraw from the study at any time. The investigators reserve the right to withdraw you from the study if they believe that it is necessary. Upon completion of both time points, you will receive $10 and be eligible to win 1 of 2 Brock bookstore gift cards of $100 each. Also, depending on what department you are in, you may be eligible to receive a mark in a class for participation.

RISKS AND BENEFITS: There is little direct risk to you. You may experience some discomfort due to the personal nature of the questions asked. You may also feel uncomfortable during the body composition test. This study poses no physical risk. Participation will allow you to become exposed to a research protocol, contribute to the advancement of science and, gain general knowledge about lifestyle habits of first year students at Brock University.

RIGHTS OF RESEARCH PARTICIPANTS: You may request to receive a signed copy of this consent form. You may withdraw your consent to participate in this study at any time, and you may also discontinue participation at any time without penalty. This research has been reviewed and received ethics clearance through the Research Ethics Board at Brock University (REB# 13-297). If you have any pertinent questions about your rights as a research participant, please contact the Brock University Research Ethics Officer (905 688-5550 ext 3035, reb@brocku.ca).

INFORMATION: Our study office is located in Welch Hall 144. Please contact our study office at brocktransitionstudy@gmail.com or 905-688-5550 ext. 5826, or any of the above investigators at any time if you have any questions about the study.

Faculty of Applied Health Sciences
Department of Kinesiology

Brock University
Niagara Region
500 Glenridge Av
St. Catharines, O
L2S 3A1 Canada
brocku.ca

Appendix C-2 Invitation Letter

INVITATION LETTER

Identifying lifestyle changes that impact students' physical and emotional wellbeing during their first year of university

Dear students,

We would like to invite you to participate in a research study.

INVESTIGATORS: Dr. Andrea Josse (x. 3502), Dr. Nota Klentrou, Dr. Kimberley Gammage, Dr. Bareket Falk and Dr. Cameron Muir. We are from the Faculties of Applied Health Sciences and Social Sciences.

PURPOSE OF THE STUDY: To identify the key health-related issues and lifestyle changes that may occur as students' transition from high school to university and undergo their first year in university. We would also like to investigate whether ethnicity and gender play a role. Specifically, we will be assessing changes in nutrition, exercise and sleep habits, as well as changes in stress levels, body image, body weight and body composition during this time.

INCLUSION CRITERIA: You may participate in this study if you are entering your first year at Brock University, you are between the ages of 17-20, and you speak and understand English.

EXCLUSION CRITERIA: You are not eligible to participate in this study if you are transferring programs within Brock or have already completed a first year of University elsewhere.

TIME COMMITMENT: There are 2 time points in this study and 2 hours per time point. The total time commitment involved is 4 hours. Each time point consists of a 1 hour visit to the Nutrition Laboratory (WH144) and 1 additional hour to fill out online surveys. Testing sessions will be in late-August/September and March/April. Upon completion of both time points, you will receive $10 and be eligible to win 1 of 2 Brock Bookstore gift cards of $100 each. Also, depending on what department you are in, you may be eligible to receive a mark in a class for participation.

STUDY PROCEDURES: If you agree to participate in this study, you will be asked to:

(1) fill out a series of questionnaires pertaining to nutrition, exercise, body image, sleep, stress and mental health (most online and 1 on paper).

(2) undergo body measurements (height, weight, waist circumference, hip circumference).

(3) undergo body composition measures in 2 ways (Bioelectrical Impedance Analysis and Ultrasound).
(4) provide a saliva sample.

If you are interested in finding out more about this study, please contact our study office by email (brocktransitionstudy@gmail.com) or by phone (905-688-5550 ext: 5826).

This research has been reviewed and received ethics clearance through the Research Ethics Board at Brock University (REB# 13-297). If you have any questions about your rights as a research participant please contact the Research Ethics Office at 905-688-5550 x 3035 or reb@brocku.ca

Thank you,
TRANSITION Project investigators

Appendix C-3 Recruitment Poster

VOLUNTEER FOR THE BROCK TRANSITION STUDY!!

PURPOSE OF STUDY: To identify the key health-related issues and lifestyle changes that may occur as students' transition from high school to university and undergo their first year in university.

CRITERIA:

NEW Brock University students entering 1st year, 17-20 years old

Exclusion: if you are transferring programs within Brock or have already completed a first year of university elsewhere.

PARTICIPATION:

How often and how long: only 2 time points, 2 hours each time point for a total of 4 hours

Where: Nutrition Laboratory (WH144) and online

What: answering a series of questionnaires about diet, exercise habits, body image, giving a saliva sample, measuring body composition

CHANCE TO WIN 1 of 2 BROCK BOOKSTORE GIFT CARDS of $100 each!!! PAYMENT of $10 CASH upon completion of both sessions!!

CONTACT INFORMATION:
Brock Transition Study Office is in WH144.
brocktransitionstudy@gmail.com or 905-688-5550 ext 5826.

This research has been reviewed and received ethics clearance through the Research Ethics Board at Brock University (REB# 13-297). If you have any questions about your rights as a research participant please contact the Research Ethics Office at 905-688-5550 x 3035 or reb@brocku.ca

Appendix C-4 SONA Ad

BROCK UNIVERSITY
Department of Psychology

Application for Access to the Psychology Research Pool

All studies posted to the Psychology Research Pool website must have Research Ethics Board (REB) clearance.

INSTRUCTIONS:

Please complete the information below about your study and then email this form to (lindap@brocku.ca) **with the subject line RESEARCH POOL.**

ATTACH A COPY OF YOUR INFORMED CONSENT FORM TO THE EMAIL.

****

NAME OF RESEARCHER(S):
Kayleigh Beaudry, MSc student, FAHS, x5826
Aysha Thomas, MSc student, FAHS, x5826

RESEARCHER(S) EMAIL: brocktransitionstudy@gmail.com ; kb10ky@brocku.ca ; at14xh@brocku.ca

FACULTY ADVISOR (if applicable): Dr. Andrea Josse, FAHS, x. 3502
Dr. Cameron Muir, FSS, x. 4681

TITLE OF STUDY: Identifying lifestyle changes that impact students' physical and emotional wellbeing during their first year of university

BRIEF DESCRIPTION: The purpose of our study is to identify the key health-related issues and lifestyle changes that may occur as students' transition from high school to university and undergo their first year in university. Specifically, we are assessing changes in nutrition, exercise, sleep habits, stress levels, body image, mental health,

body weight and body composition during this critical period. You will be asked to fill out a series of questionnaires, give a saliva sample and have your body composition measured. You may choose to see your results at the end of the study (if interested).

IS THIS A TWO PART STUDY?: Yes

LENGTH OF STUDY (e.g. .5, 1, 1.5, 2, …. hours): 4 hours (2 hours for each session)

SELECTION CRITERIA: You may participate in this study if you are entering your first year at Brock University, you are between the ages of 17-20, and you speak and understand English. You are not eligible to participate in this study if you are transferring programs within Brock or have already completed a first year of University elsewhere.

CREDIT/PAY (choose one or the other)
(e.g. 30 minute study is .5 credit, 1 hour study is 1 credit, etc.): 2 credits for the first session and $10 for completion of both sessions.

ETHICS CLEARANCE NUMBER (REB #): REB# 13-297

ETHICS EXPIRY DATE: July 31, 2016

Appendix C-5 Ethics Clearance

Brock University
Research Ethics Office
Tel: 905-688-5550 ext. 3035
Email: reb@brocku.ca

Bioscience Research Ethics Board

Certificate of Ethics Clearance for Human Participant Research

DATE:	July 6, 2015	
PRINCIPAL INVESTIGATOR:	JOSSE, Andrea - Kinesiology	
FILE:	13-297 - JOSSE	
TYPE:	Faculty Research	STUDENT: SUPERVISOR:

TITLE: Identifying lifestyle changes that impact students' physical and emotional wellbeing during their first year of university

ETHICS CLEARANCE GRANTED

Type of Clearance: MODIFICATION Expiry Date: 7/31/2016

The Brock University Bioscience Research Ethics Board has reviewed the above named research proposal and considers the procedures, as described by the applicant, to conform to the University's ethical standards and the Tri-Council Policy Statement.

Modification: Compensation and course marks

The Tri-Council Policy Statement requires that ongoing research be monitored by, at a minimum, an annual report. Should your project extend beyond the

expiry date, you are required to submit a Renewal form before **7/31/2016**. Continued clearance is contingent on timely submission of reports.

To comply with the Tri-Council Policy Statement, you must also submit a final report upon completion of your project. All report forms can be found on the Research Ethics web page at http://www.brocku.ca/research/policies-and-forms/research-forms.

In addition, throughout your research, you must report promptly to the REB:

a) Changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;
b) All adverse and/or unanticipated experiences or events that may have real or potential unfavourable implications for participants;
c) New information that may adversely affect the safety of the participants or the conduct of the study;
d) Any changes in your source of funding or new funding to a previously unfunded project.

We wish you success with your research.

Approved: 

Brian Roy, Chair
Bioscience Research Ethics Board

Note: Brock University is accountable for the research carried out in its own jurisdiction or under its auspices and may refuse certain research even though the REB has found it ethically acceptable.

If research participants are in the care of a health facility, at a school, or other institution or community organization, it is the responsibility of the Principal Investigator to ensure that the ethical guidelines and clearance of those facilities or institutions are obtained and filed with the REB prior to the initiation of research at that site.